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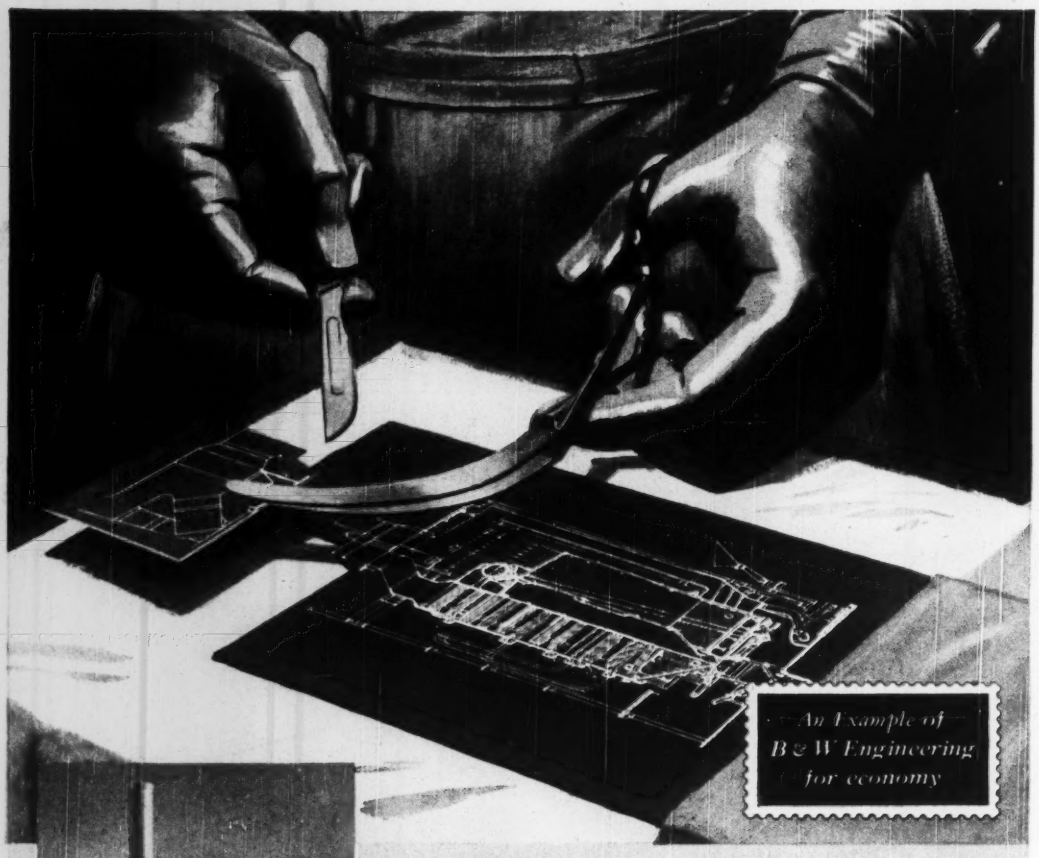
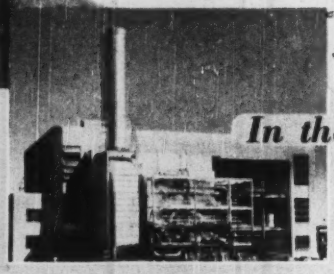




In the New B&W Pressure-Furnace Boiler

...Steam Costs Undergo Major Surgery

Drawing the massive "breath" that a boiler needs every hour to convert, in some instances, over a million pounds of water into high-pressure, high-temperature steam is a major operating expense. *Conventionally,* huge fans blow a gale of air into the furnace; others—the induced-draft fans—exhaust the combustion gases out the stack.

Now, B&W boilers with pressure-furnaces retire induced-draft fans from their punishing service . . . strike them from the list of high equipment, power, and maintenance costs.

Pressurized operation offers other advantages, too. Controls and boiler design are simplified; the leak-proof casing permits a higher degree of fuel-burning efficiency.

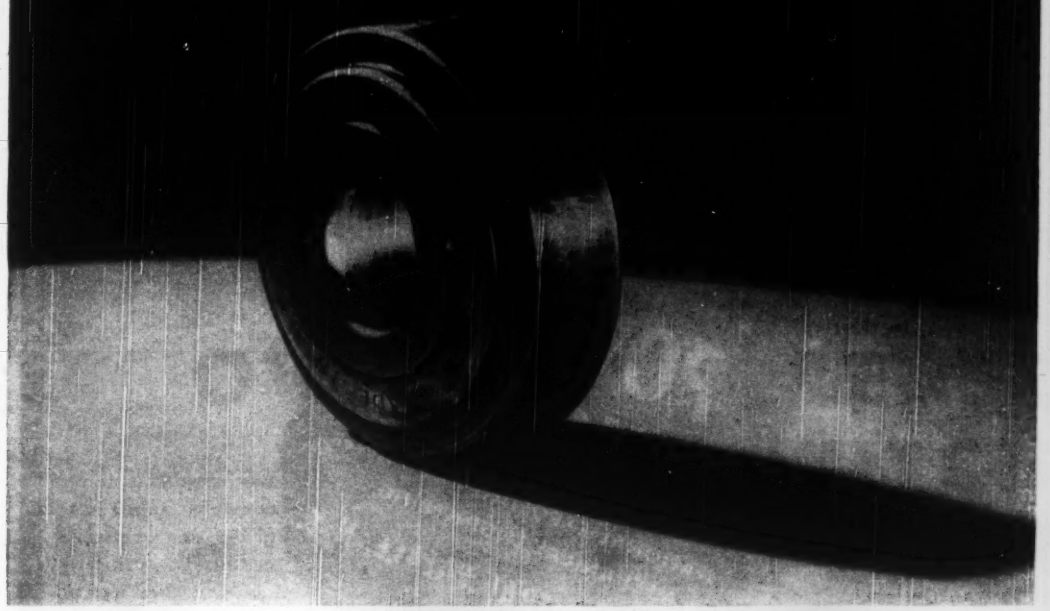
A creative approach to boiler design and application, in cooperation with far-sighted managements and power engineers, has identified B&W with steam-power progress for more than 80 years. Perhaps it's just what is needed to effect significant steam-generating economies in the solution of *your* present problems or future plans.

BABCOCK & WILCOX

N-88

Helping Industry Cut Steam Costs Since 1867—through Research, Engineering, Equipment, Installation and Maintenance Services

Granddad of a Famous Family....



This self-sealed ball bearing, one of the earlier types originated by New Departure, was removed and examined in the twentieth year of its service in a grinder. No appreciable wear had occurred and the internal fit-up was still *well within* the tolerances of a new bearing.

While this is eminently satisfactory, but not unusual service, it points up the significant fact that for assured performance, for the ability to eliminate periodic adjustments and to reduce lubricating or other maintenance to the simplest possible terms, the ball bearing is *outstanding*.

It was full knowledge of the distinctive advantages of the ball bearing that led New Departure to pioneer and develop the self-sealed bearing, including many lubricated-for-life types, some of which are illustrated at each side.

This hard worked "Granddaddy", progenitor of a famous family, thus started a trend that has required New Departure to produce more than 159 million self-sealed ball bearings to date.

Data covering ball bearing dimensions, application, lubrication and other subjects gladly sent upon request.

NEW DEPARTURE BALL BEARINGS

NEW DEPARTURE · Division of GENERAL MOTORS CORPORATION · BRISTOL, CONNECTICUT · BRANCHES IN ALL PRINCIPAL CITIES

MECHANICAL ENGINEERING, September, 1950, Vol. 72, No. 9. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

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Outstanding presentation of equipment for production and utilization of steam, electric, and mechanical power . . .

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- Over 300 informative displays and interesting demonstrations of latest developments for improving power production and utilization.
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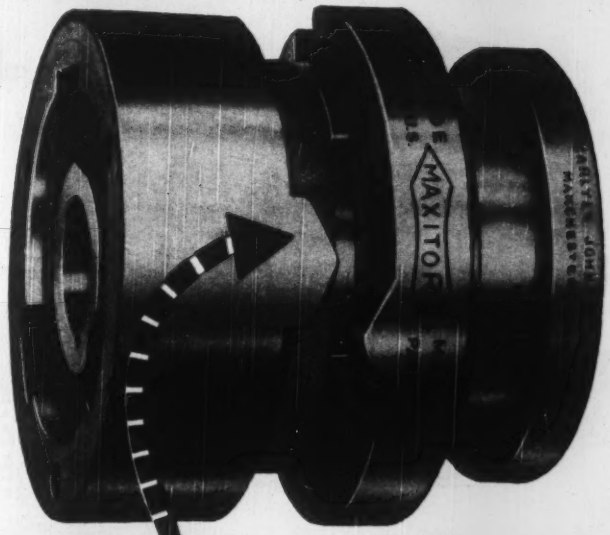

Automatic

OVERLOAD *RELEASE* CLUTCH

When an accidental overload occurs on some types of today's high speed automatic machinery . . . packaging, can and bottle labeling machines, for instance . . . confusion reigns. Bottles may be broken and jammed, labels spoiled, machine mechanisms damaged . . . perhaps operator injured. And expensive down-time bites into profits.

But . . . not if your power transmission is protected by the Maxitorq automatic Overload Release Clutch. When overload is a heavy shock or is substantially greater than normal driving load, the clutch instantly and automatically releases. When jammed condition is cleared, the clutch is re-engaged and operation continues. A simple finger-tip adjustment sets the clutch to transmit the normal running load.

OVERLOAD RELEASE TYPE CUPS are the means for connecting the clutch to the driven or driving member. Hub, Ring, Flange or Cut-off Coupling types are available to suit specific conditions.

Maxitorq "Floating discs" actually ride free in neutral . . . preventing drag, abrasion and heat. There are 6 standard clutch sizes with capacities from ¼ to 5 H.P. at 100 r.p.m. Types are wet or dry, single or double, the latter on special order.

The Overload Release Clutch *does* have definite limitations . . . it must be properly applied for maximum effect. Maxitorq engineers, experienced in its varied applications, will gladly provide practical recommendations. Complete specifications on request.

Send for NEW Bulletin No. ME 9

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

Norblo Bag Type

DUST AND FUME COLLECTION

One particular Norblo installation of Norblo Automatic Bag Type Dust Collectors (in tandem) moves more than *four million tons of air a year*. This unit is collecting a scarce and valuable metal previously recovered less efficiently. The difference represents a substantial increase in profit.

Pre-eminent in the smelting, mining, cement and rock products fields, Norblo Automatic Bag Type Dust and Fume Collection provides dependable, heavy duty continuous service at low cost. In the smelting field right now the extra production capacity of Norblo automatics is paying off handsomely. Write for Bulletin No. 164-2 – today!

tackles the biggest jobs...

production at low cost

THE NORTHERN BLOWER COMPANY

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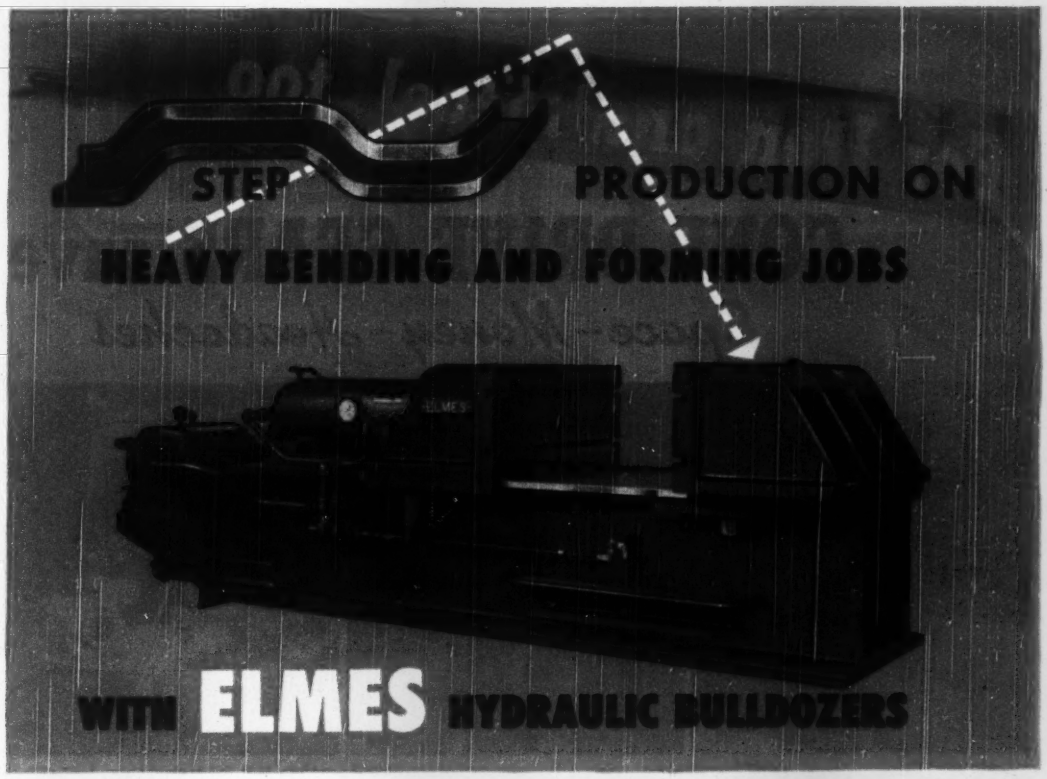
Automatic and Standard Bag Type Fume and Dust Collectors • Norblo Centrifugal and Hydraulic Collectors • Cement Air Cooling Systems • Exhaust Fans



Here is a highly *versatile* Elmes Hydraulic Press that will save you both *time* and *money* on heavy bending and forming operations. The controlled, cushioned squeeze of Elmes hydraulic power eliminates pre-setting or re-setting of press stroke for (1) job changes, (2) variations in stock size. To change jobs—just change dies! Full pressure can be applied at any point in the stroke and length of stroke can be varied to suit the individual job.

Elmes Hydraulic Bulldozers are available in both standard and special designs to meet any capacity requirement. Bed size, stroke and speed are optional to suit your service needs.

These presses have T-slots in platen and resistance head for mounting dies. Resistance head is adjustable for close-gap work. Other standard features are fixed stop reversal, extra-long removable guides on platen, sensitive tip-toe control, high-speed operation. Pumping unit is located on end of press, for protection against overhead traveling materials.

For nearly a century, Elmes hydraulic equipment has solved the pressing problems of industry. Why not ask Elmes to assist in the selection or design of the right metal-working press for *your* production? Recommendations and cost estimates are yours for the asking!

Write for Bulletin 1010-B, "Hydraulic Metal-Working Presses."

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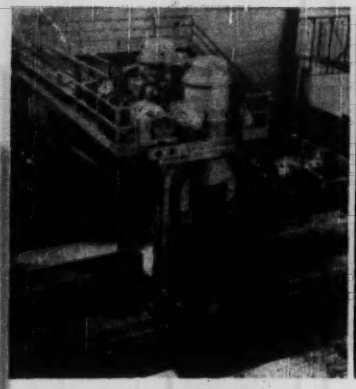
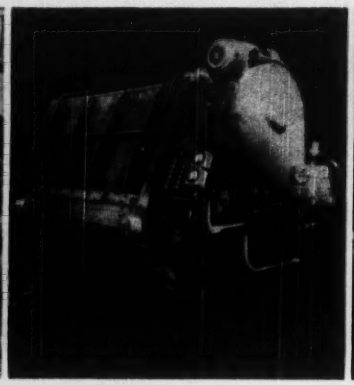
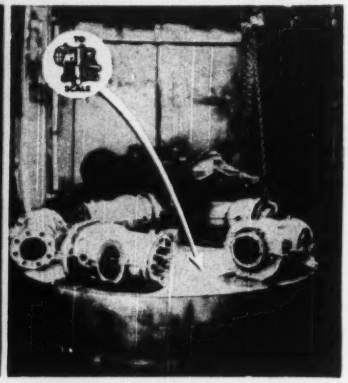






HANDLE HEAVY DUTY LOADS

For example, this Morgan Engineering Company 40″ blooming mill, like other Morgan equipment (box-chargers, trolleys, etc.) uses Cone-Drive gears to handle the full torque heavy-duty shock loads of the screw-downs. Center distance of the gear sets is only 24 in. to handle 150 hp at 460 rpm using a mill type motor. It would take a much larger non-Cone-Drive gear set to approach the same load capacity, of course.

SAVE MONEY IN CONTINUOUS SERVICE

Wheelabrator Tumblasts know how to "take it"—the loader and mill are operated through standard Cone-Drive reducers. WHY? American Wheelabrator & Equipment Corporation says: "We use Cone-Drives for this application because they conserve space, give us freedom from service trouble and SAVE US MONEY." The unit shown (under construction) has a capacity of 30 cu. ft. of castings. The reducer is a 5″ center distance (4.6 hp at 780 rpm) Cone-Drive.

GIVE RESERVE CAPACITY IN LIMITED SPACE

This Hydro-Blast turn-table turns 25 tons of castings at one time under high pressure streams of sand and water. Operated through a Cone-Drive double-reduction unit (600 to 1) made up of *standard* 2½″ and 5″ reducers. Over-all height is less than 19 in. Nearest other reducer would have been 26″ high. Yet the Cone-Drive reducer (shown to scale) has a torque capacity of 25,000 in.-lbs, some 11,000 in.-lbs in excess of actual requirement.

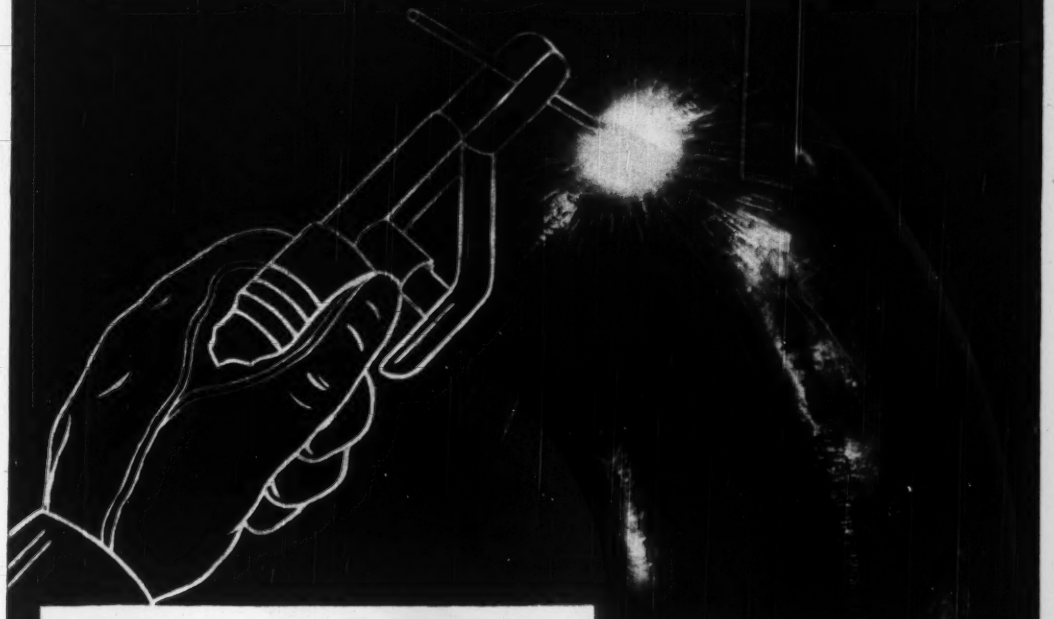
CONE-DRIVE GEARS

CONE-DRIVE GEARS *Division, Michigan Tool Company*

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, U.S.A.

WeldELLS®



...There are no fittings like WeldELLS

When we say there are no welding fittings like WeldELLS we feel that we are simply repeating the expressed opinions of thousands who know pipe welding.

Often it is the opinion of a designer who recognizes the engineered strength distribution and closely controlled metallurgy of these fittings that are designed by engineers.

Frequently, it is the opinion of a construction superintendent, maintenance man, or welding foreman who has discovered job-speeding, cost cutting features in WeldELLS that are combined in no other fittings.

Sometimes it is the opinion of those whose unusual requirements can only be satisfied in the broader Taylor Forge line; for in certain sizes, weights and materials it can be truthfully said that *there are no fittings* BUT *WeldELLS!*

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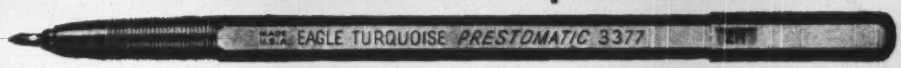
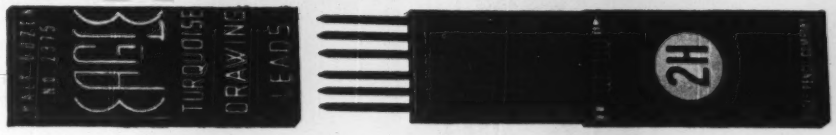
SEARCHING for the perfect lead holder?



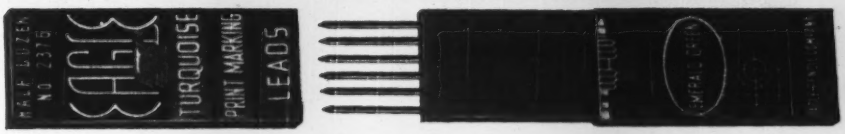
You'll find it in Eagle PRESTOMATIC. Its *rifled* jaws keep a firm, sure grip on the lead . . . never let it push back . . . never bite it off. Non-rolling, featherweight, aluminum barrel makes a permanently beautiful, precision drafting instrument. Handy press-cap quickly controls jaws for lead adjustment. Changeable indicator instantly adaptable to any degree of lead.

SEARCHING for the ideal drawing leads?



Look no further . . . Eagle TURQUOISE Drawing Leads are exactly what you want. They're the same smooth, strong, opaque leads as in famous Eagle TURQUOISE drawing pencils. 15 grades . . . 4B to 9H. Uniform .078" diameter and 5⅛" length.

SEARCHING for colored print-marking leads?



Here they are . . . the same strong, brilliant, *insoluble* leads as in famous Eagle VERITHIN pencils. Vermilion, yellow, white and emerald green for marking blueprints; blue for filling in unwanted white lines; carmine red for marking all black and white prints. PRESTOMATIC lead holders come with a colored cap to match each lead.

Lead Holder . . . **$1**
Leads . . . black or colored . . . **10¢** *each*

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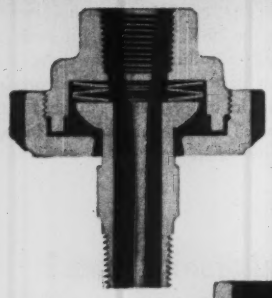
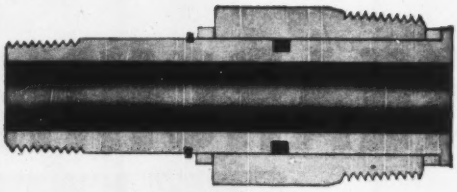
BARCO Flexible, Swivel and Revolving Joints

A complete range of design

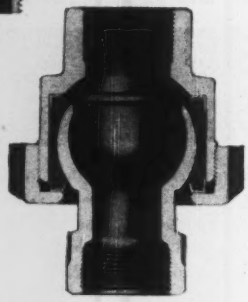
Select the one fitted to your specific needs



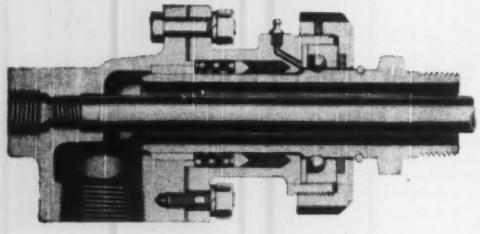
Barco Rotary Swivel Joints for use with air, oil, gas, steam, water and other fluids provide slow rotation with side flexibility.



Barco Swing Joint for hose reels, loading and unloading lines, and for tank cars and trucks—compact, inexpensive, durable.



Barco Flexible Joints for conveying oil, steam, gasoline, water, tar, corrosive acids and alkalis —where flexibility in piping is required.



Barco Revolving Joints supply steam, gas or other fluids from a fixed supply pipe to a rotating drum or member with low friction "drag." Sizes from ¼" to 5".

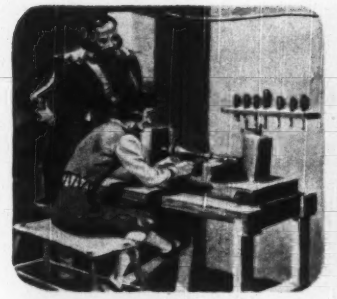
There is a Barco Joint for each particular problem in pipe flexibility. Different designs are available for:

- **Combined angular and swivel motion**
- **Swivel and slow rotation combined with angular motion**
- **Swing action with no side flexibility**
- **High-speed rotation**

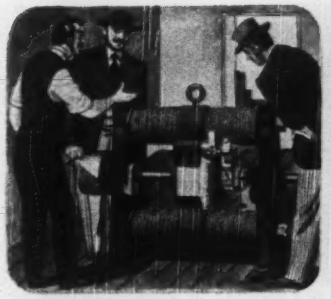
There's a Barco Joint to handle any type of fluid with wide temperature and pressure ranges and a variety of metals and gasket materials. For more information about this *complete* line of joints, write Barco Manufacturing Company, 1821 J Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal.

BARCO THE ONLY TRULY COMPLETE LINE OF FLEXIBLE, SWIVEL AND REVOLVING JOINTS

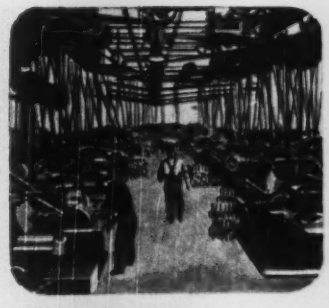
FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY



1 1600—Man worked hard for his pay in these days. Crude machines like this began to lighten his load by replacing laborious handwork with foot power. But progress was really only beginning.

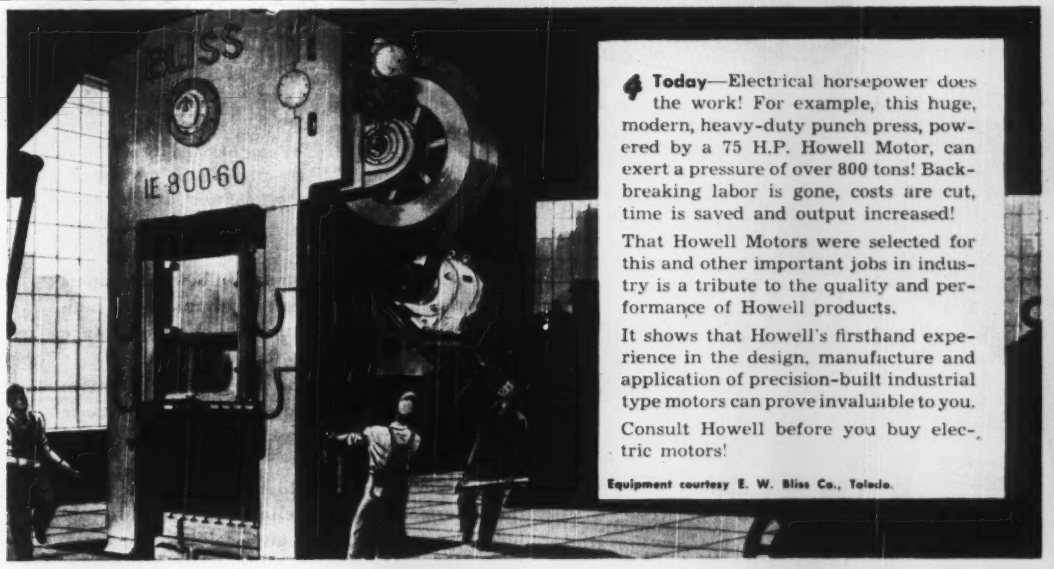


2 1875—By accident, it was discovered that if two direct current dynamos were connected together, one would serve as a generator and drive the other as a motor. Electrical horsepower was here!



3 1900—Result: Electrical horsepower replaced foot power! By 1915, Howell "Red Band" Electric Motors arrived. Soon, these rugged, industrial type motors were widely accepted in many industries.

NOW...A PUNCH PRESS WITH A PUNCH!



4 Today—Electrical horsepower does the work! For example, this huge, modern, heavy-duty punch press, powered by a 75 H.P. Howell Motor, can exert a pressure of over 800 tons! Back-breaking labor is gone, costs are cut, time is saved and output increased!

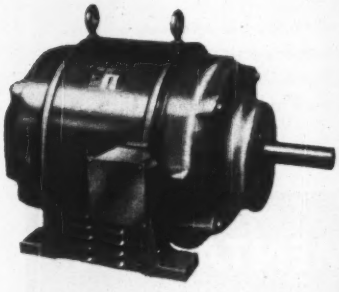
That Howell Motors were selected for this and other important jobs in industry is a tribute to the quality and performance of Howell products.

It shows that Howell's firsthand experience in the design, manufacture and application of precision-built industrial type motors can prove invaluable to you.

Consult Howell before you buy electric motors!

Equipment courtesy E. W. Bliss Co., Toledo.

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.



Howell Type F Punch Press Motor

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

HOWELL Red Band MOTORS

The New Dynatherm*

- Super-fast Response.
- Highest Sustained Accuracy . . . permits use with very narrow scales.
- Positive Metal-to-Metal End-Contact with Well or Socket.
- Fits Any Well or Socket over ¼" Inside Diameter.
- Also available with shell made completely of #316 stainless steel for use without socket in corrosive service.

The new Dynatherm Resistance Bulb, with its super-fast end-contact, combines the advantages of both thermocouple and resistance type temperature measurement in ranges up to 600°F.

For the first time, it is now possible to benefit from the inherent accuracy and stability of a resistance bulb, without premium cost or the need for special wells or sockets.

The Dynatherm offers higher sustained accuracy than thermocouples. It eliminates need for cold junction compensation . . . gives stability in measurement impossible with thermocouples. This resistance bulb is so sensitive throughout its entire range that full accuracy is maintained even on narrow scales, and its speed, when used in a socket, is equal or superior to that of a thermocouple similarly protected. Write for full details. **The Foxboro Co., 182 Neponset Avenue, Foxboro, Mass., U. S. A.**

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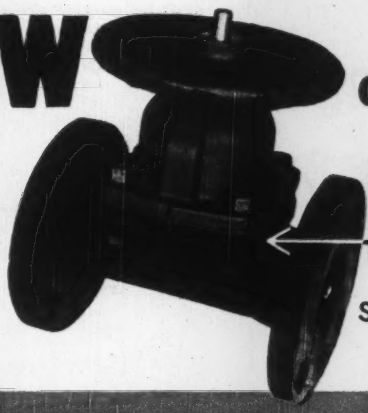
NOW chemically inert KEL-F* diaphragms for GRINNELL-SAUNDERS DIAPHRAGM VALVES



H_2SO_4 H_2CrO_4 HCL HNO_3 HF

C_6H_5CL Br_2 $SiCL_4$ CH_3COCH_3 CCL_4

*KEL-F is the registered trade name for polytrifluorochloroethylene, an exceptionally stable thermoplastic produced by The M. W. Kellogg Company. Its resistance to chemical action, low cold flow, wide range of temperature application and flexibility combine to make KEL-F the most important diaphragm development in the past ten years. It is chemically inert to all inorganic acids, alkalies and the like with the exception of molten alkaline metals such as sodium. KEL-F is also chemically inert to organic materials but may be plasticized or swelled slightly by halogenated organic materials. However, test installations indicate that this plasticizing or swelling action is of minor consequence and in the majority of cases does not affect valve operation.

plus all these unique valve features

Diaphragm lifts high for streamlined flow in either direction . . . Smooth, streamlined passage, without pockets, prevents trapping of sludge and reduces frictional resistance to a minimum — irrespective of direction of fluid flow. No disc holder in fluid stream. Grinnell-Saunders Diaphragm Valves are self-draining when installed with the spindle at 15 degrees above the horizontal position.

Diaphragm absolutely isolates working parts from fluid . . . There's no "if" about the way a continuous, one-piece diaphragm seals off the working parts from fluids; no perforation or puncture in the diaphragm where fluid or gas can possibly leak by the valve spindle. No sticking, clogging or corroding of working parts. Valve lubricant cannot contaminate the fluid in the line.

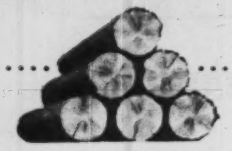
Diaphragm, body and lining materials to meet particular conditions . . . Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum: other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

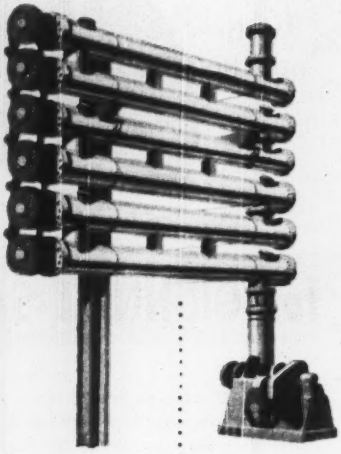
Diaphragm is only part that normally wears and needs replacement . . . Depending on the type of service, it may last for years, particularly since the compressor and finger plate combine to support the diaphragm in all positions. The diaphragm can be replaced quickly without removing valve from line. No refacing or reseating.

GRINNELL

Grinnell Company, Inc., Providence, R. I. Branches: Atlanta • Billings • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

How Continuous Cooking and Pulping Equipment Cuts Costs





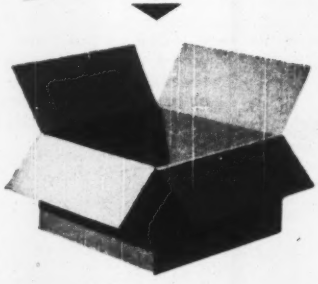
PROJECT: *To replace batch pulp cooking economically and gain advantages of continuous cooking in mono-sulphite or alkali-treating mediums for production of free fibre in a southern paper mill.*

EQUIPMENT: *Modern pulpmaker for continuous cooking and pulping. A Chemipulper, with three-unit reaction chamber having sturdy rigid tubes of acid- or alkali-resisting Lukens Stainless-Clad Steel and stainless steel continuous-feed screw conveyors.*

END RESULT: *Easy control of time, pressure and temperature with measured continuous chip and chemical feed. Greater volume with less manpower. More uniform pulp from hard or soft woods. No corrosion. Low operating and maintenance costs. Longer equipment life.*

These benefits are typical of results achieved with newly developed, more efficient pulp and paper equipment. And wherever design, fabrication and materials selection must be critically coordinated, you will find the economical answer in applied *Lukenomics*. Lukenomics combines the experience of designers, engineers and equipment builders with Lukens' knowledge of materials and their application gained over 140 years as the world's leading producer of specialty steel plates, heads and steel plate shapes.

It's sound investment insurance to put Lukenomics to work on your equipment problems. There are progressive fabricators who can do this for you. Get in touch with them or write our Manager of Marketing Service, stating your problem. There's a Lukenomics team ready to go to work on it. Lukens Steel Company, 402 Lukens Building, Coatesville, Pa.



The unit illustrated was fabricated by Alloy Fabricators for Paper and Industrial Appliances, Inc., distributors of the Chemipulper. The reaction chamber tubes are made of 20% Lukens Stainless-Clad Steel, Type 304.

LUKENS STEEL COMPANY

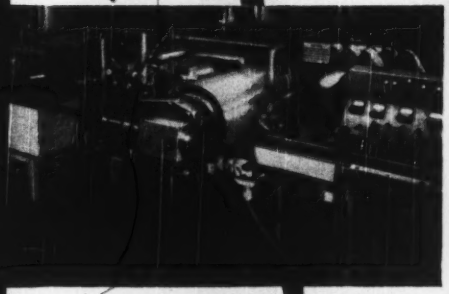
BETTER PRODUCTS FOR BETTER EQUIPMENT

Oilgear unit drives cable take-up reels. By an ingenious Oilgear control arrangement, all units are kept in perfect step over entire 150 feet of Alpeth sheathing process.

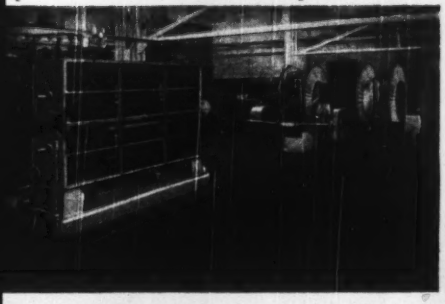
WESTERN ELECTRIC'S

OILGEAR FLUID POWER

Oilgear fluid p[illegible]r drives Yoder roll forming machine whic[illegible]aps corrugated aluminum sheathing arou[illegible]able.



Oilgear drives [illegible] synchronized to speed of Royle [illegible]der which covers cable with mol[illegible]olyethylene.



Tractor capstan powered by Oilgear, which pulls cable through extruder, long cooling trough and inspection station.

● Right after the war, the Bell System faced a tremendous problem because of the shortage of lead for sheathing telephone cable. To solve that problem, a newly designed sheath known as Alpeth—aluminum polyethylene—was adopted. And the engineers had to design a machine fast that would apply this sheath fast—to produce this new cable by the millions of feet.

Oilgear engineers, working with *standard* Oilgear Fluid Power pumps, motors and valves, met the need for drives that would handle the complex Alpeth coating machines, dependably, without trouble . . . and for drives that could be immediately, easily and economically installed . . . requiring minimum space, sure performers from the start.

The first Alpeth cable sheathing machines installed by the Western Electric Company proved themselves and more units were installed, to make a total of three at the Kearny, N. J., Works and three at Hawthorne Works in Chicago. The Oilgear drives have performed well, without trouble, with minimum maintenance, often at high speed for 24 hours a day.

A company like Western Electric does not buy by guesswork. Neither should you. THE OILGEAR COMPANY, 1 70 W. Pierce Street, Milwaukee 4, Wisconsin.

Oilgear

PIONEERS IN FLUID POWER

"Buffalo" FANS AND PUMPS USED IN FAMOUS Caribe Hilton

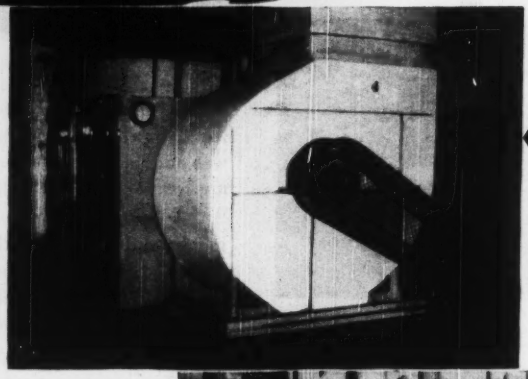
CARIBE HILTON HOTEL, built by Puerto Rico Industrial Development Company; Carrier Corp., General Air Conditioning Contractors

SPECIFY THIS "BUFFALO" EQUIPMENT FOR BEST RESULTS IN *Your* BUILDING!

Caribe Hilton, ultra-modern ten-story hotel in San Juan, Puerto Rico, is the latest triumph of the Hilton group.

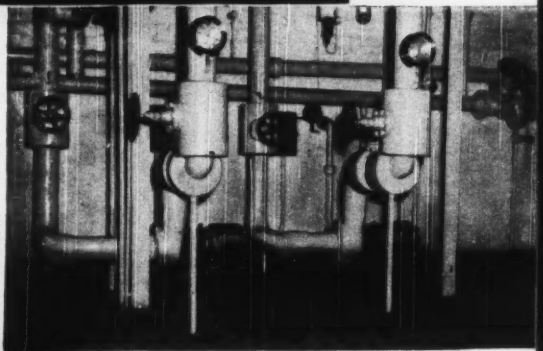
It is no coincidence that many of this hemisphere's leading public buildings and plants are served by "Buffalo" Fans and Pumps. Other users of "Buffalo" equipment are the Terrace Plaza and the Shamrock. The "Buffalo" reputation for long life and efficiency on the job goes back seventy-two years. Many "Buffalo" Ventilating Fans are still performing well after fifty or more years, while "Buffalo" Pumps are setting similar endurance records.

Be sure of the air handling and liquid handling service in YOUR building plans — specify "Buffalo".



"BUFFALO" LIMIT-LOAD FAN, popular for large-scale ventilation or air conditioning.

"BUFFALO" CLOSE COUPLED PUMPS are widely used on air conditioning service.



"Buffalo"

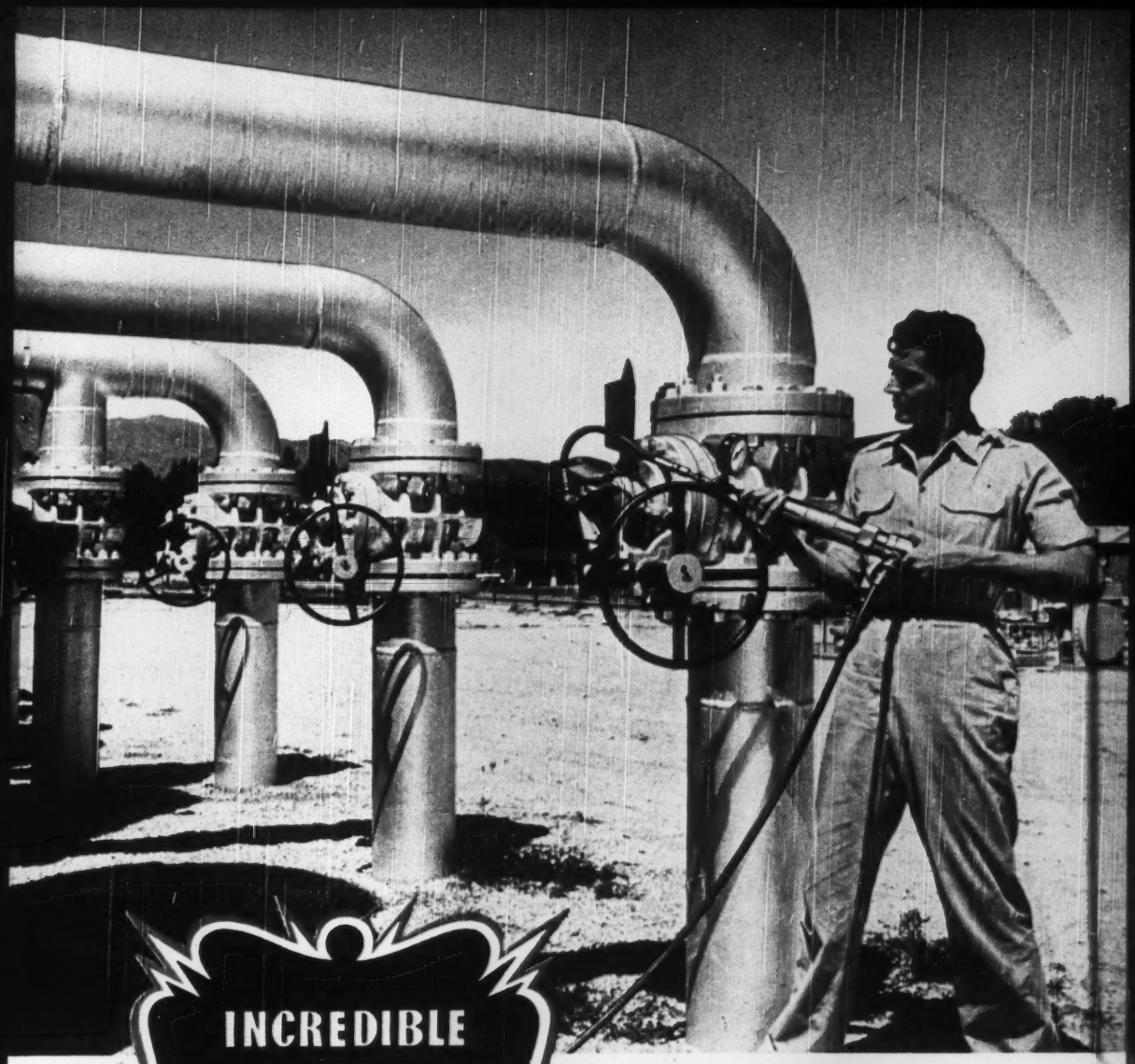
BUFFALO FORGE COMPANY

148 Mortimer St. Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities

FIRST FOR PUMPS AND FANS

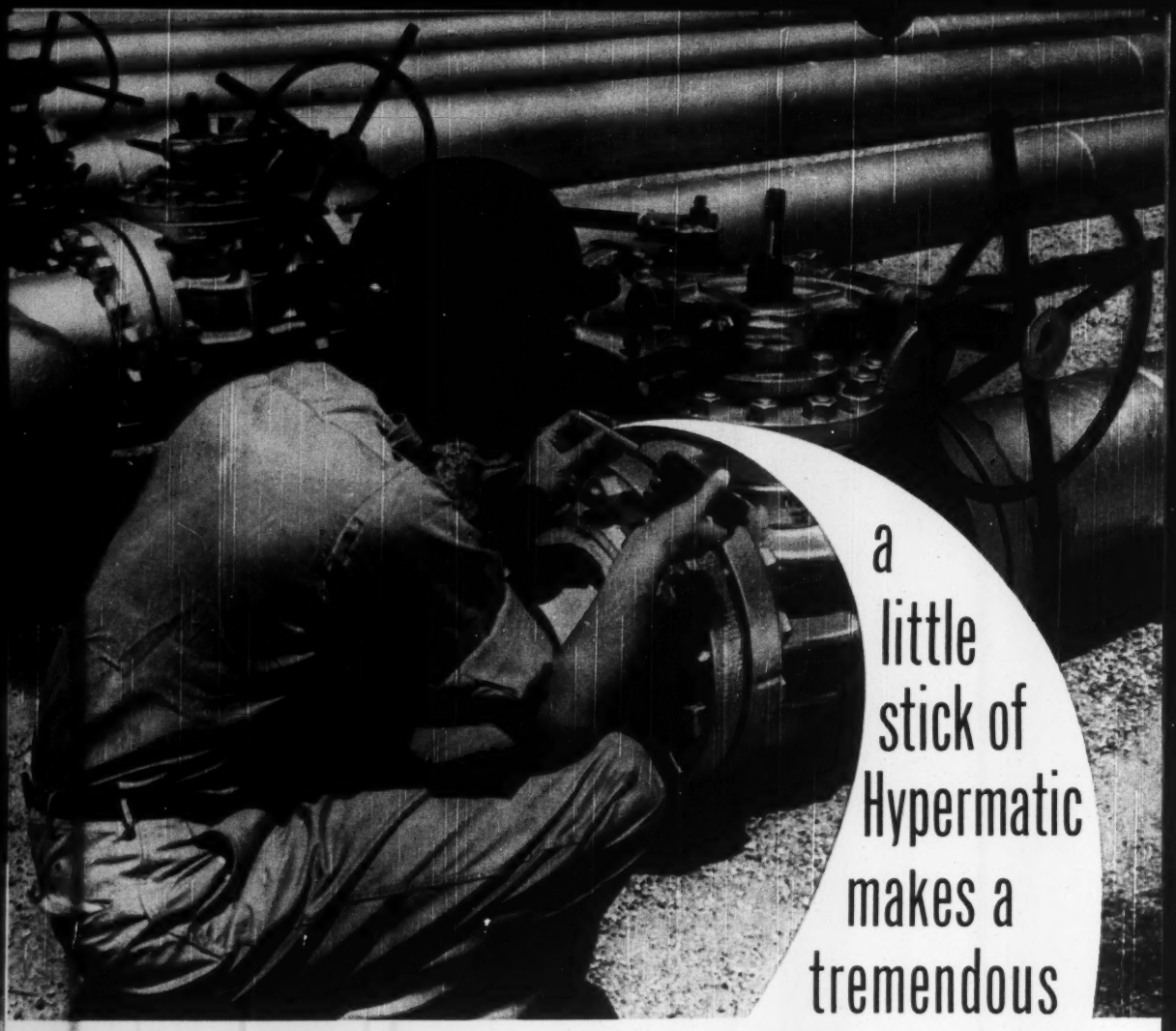


INCREDIBLE PERFORMANCE WITH THE MIRACLE LUBRICANT

MAINTENANCE costs drop to a new low; valve efficiency is tremendously increased; operation is vastly improved—by the using of Rockwell Hypermatic lubricant in Nordstrom valves. Leakage is positively prevented by keeping the valves in a 100% lubricated condition—and with less frequent relubrication. In all of your Nordstrom valves, use Hypermatic.

Keep upkeep down

Nordstrom VALVES *Automatically Lubricated*



a little stick of Hypermatic makes a tremendous difference in valve life

●

NORDSTROM LUBRICANT
PROTECTS THE SEAT
SEALS THE PORTS
JACKS THE PLUG

● That stick of Rockwell Hypermatic lubricant is the miracle that converts Nordstrom valves to *automatic* lubrication. It is energized by screwing down the lubricant screw. It impounds energy to constantly apply pressure so that no leak can develop internally. Lubrication is the most important feature in a valve. In the Nordstrom valve it assumes tremendous importance because it performs the *triple* function of sealing the ports, lubricating the unexposed seat and jacking the tapered plug if necessary, PLUS the newest advantage — *automatic* lubrication. *Keep upkeep down.* Use genuine Rockwell lubricants. *It pays.*

Nordstrom VALVES

Nordstrom Valve Division **ROCKWELL MANUFACTURING CO., Pittsburgh 8, Pa.** *District offices in all principal cities*

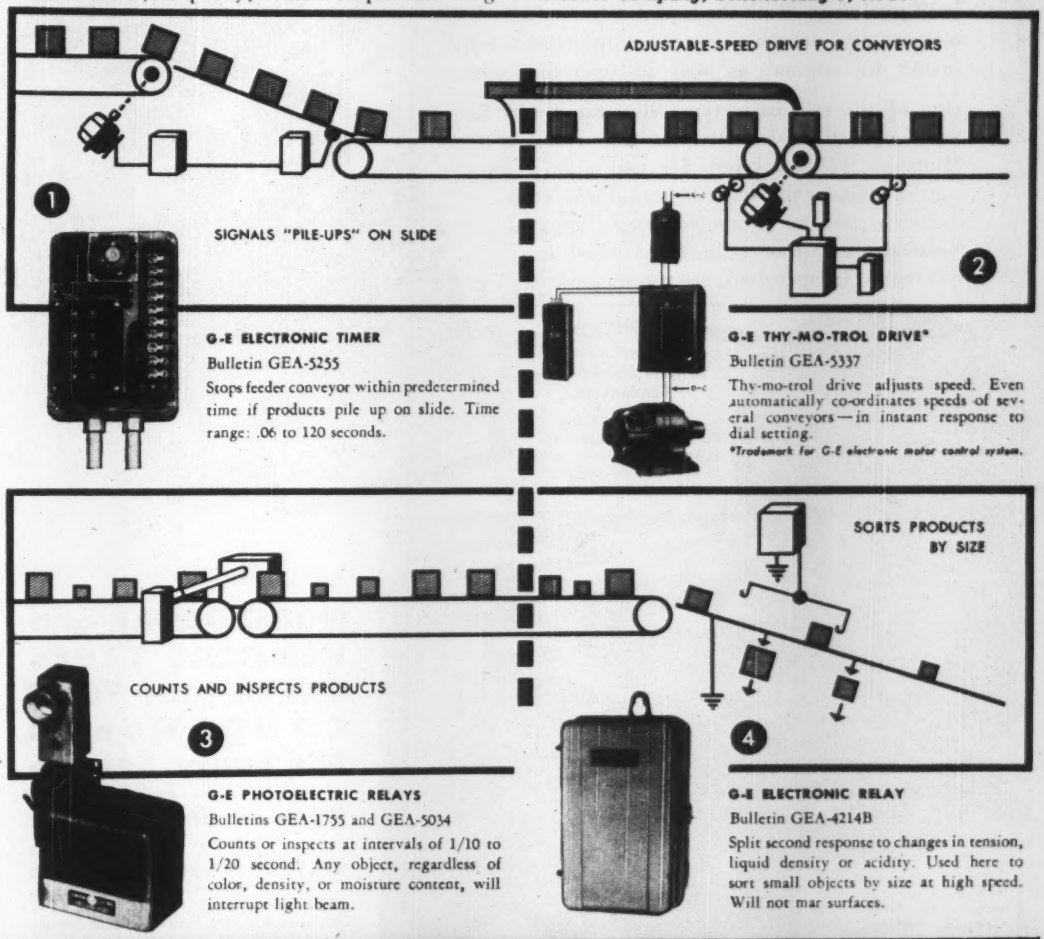
PRACTICAL APPLICATIONS OF G-E ELECTRONIC EQUIPMENT

Cut Costs . . . Speed Production automatically on finishing lines

Want to speed a process? Cut costs? Count? Sort? Inspect quantities of tiny parts rapidly? Adjust machine speed according to job? Accurately time processes? Regulate tensions in response to slight variations? Control motors automatically according to time, liquid level, temperature, or density? Want to do these jobs quietly, without frequent servicing?

You want G-E electronic devices!

See what they do on Process X—then plan how they can go to work for you. The nearest G-E sales engineer will be glad to help you select the right type for your applications; or write for bulletins for more information. ***Apparatus Dept., General Electric Company, Schenectady 5, N. Y.***



G-E ELECTRONIC TIMER

Bulletin GEA-5255

Stops feeder conveyor within predetermined time if products pile up on slide. Time range: .06 to 120 seconds.

G-E THY-MO-TROL DRIVE*

Bulletin GEA-5337

Thy-mo-trol drive adjusts speed. Even automatically co-ordinates speeds of several conveyors—in instant response to dial setting.

*Trademark for G-E electronic motor control system.

G-E PHOTOELECTRIC RELAYS

Bulletins GEA-1755 and GEA-5034

Counts or inspects at intervals of 1/10 to 1/20 second. Any object, regardless of color, density, or moisture content, will interrupt light beam.

G-E ELECTRONIC RELAY

Bulletin GEA-4214B

Split second response to changes in tension, liquid density or acidity. Used here to sort small objects by size at high speed. Will not mar surfaces.

GENERAL ELECTRIC

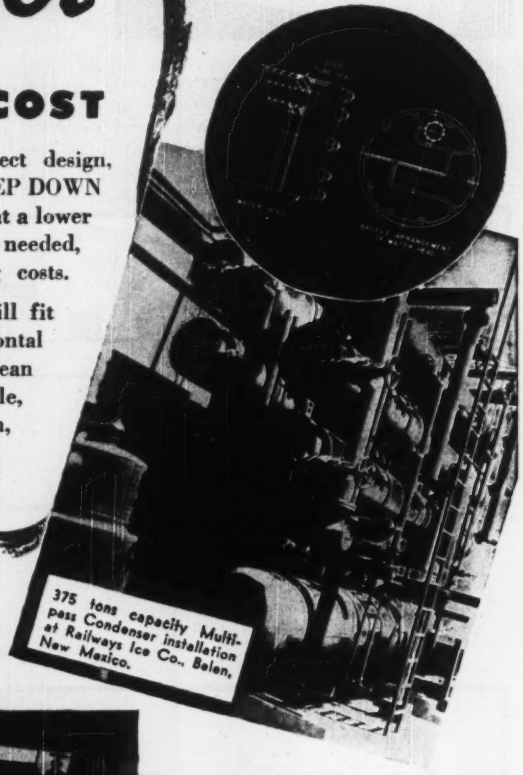
Increase knowledge of electronics with the G-E MPA Electronics Training Course. Twelve lessons for $150. Write now for information.

$ave Power and REFRIGERATION COST

Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

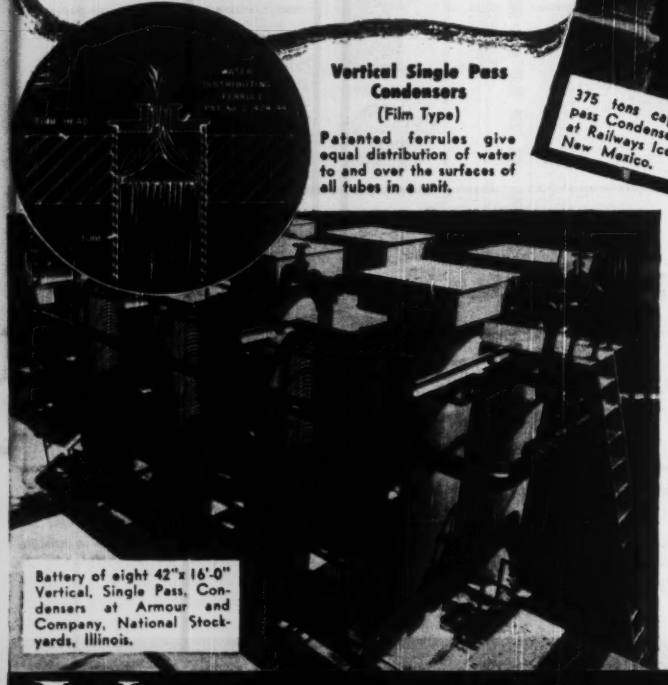
One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

Horizontal Multipass Condensers
(Closed Type)
Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.



375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.

Vertical Single Pass Condensers
(Film Type)
Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

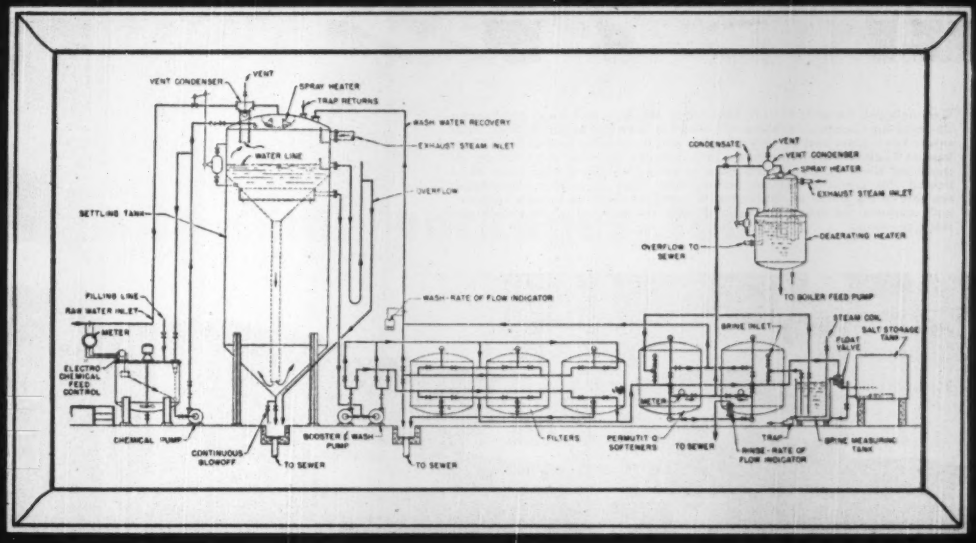
Write For Bulletin RC-1

HENRY VOGT MACHINE COMPANY
INCORPORATED
1000 W. ORMSBY ST., LOUISVILLE 10, KY., U.S.A.
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Vogt REFRIGERATION CONDENSERS

PERMUTIT ANNOUNCES...

NEW HOT ZEOLITE PROCESS



–reduces effluent from Hot Lime Soda Softener to ZERO HARDNESS

Some good reasons why you'll want this Amazing Process for your plant:

- **Chemical costs are lower**
- **Lower alkalinity and lower total solids in effluent**
- **No need for acid feeding to prevent deposits in high stage heaters and economizers.**

Here is the best way yet devised to produce water low in alkalinity and silica . . . and with all hardness removed!

This has been made possible by the development of Permutit Q, an ion exchanger which will withstand boiling water with a pH over 10. Experience shows it is not seriously affected under such operating conditions, even after 1300 regeneration cycles.

Treatment by Permutit Q is more economical than phosphate and at the same time it reduces CO_2 in the steam. Easily controlled, this new process softens water completely without regard to variable raw water hardness.

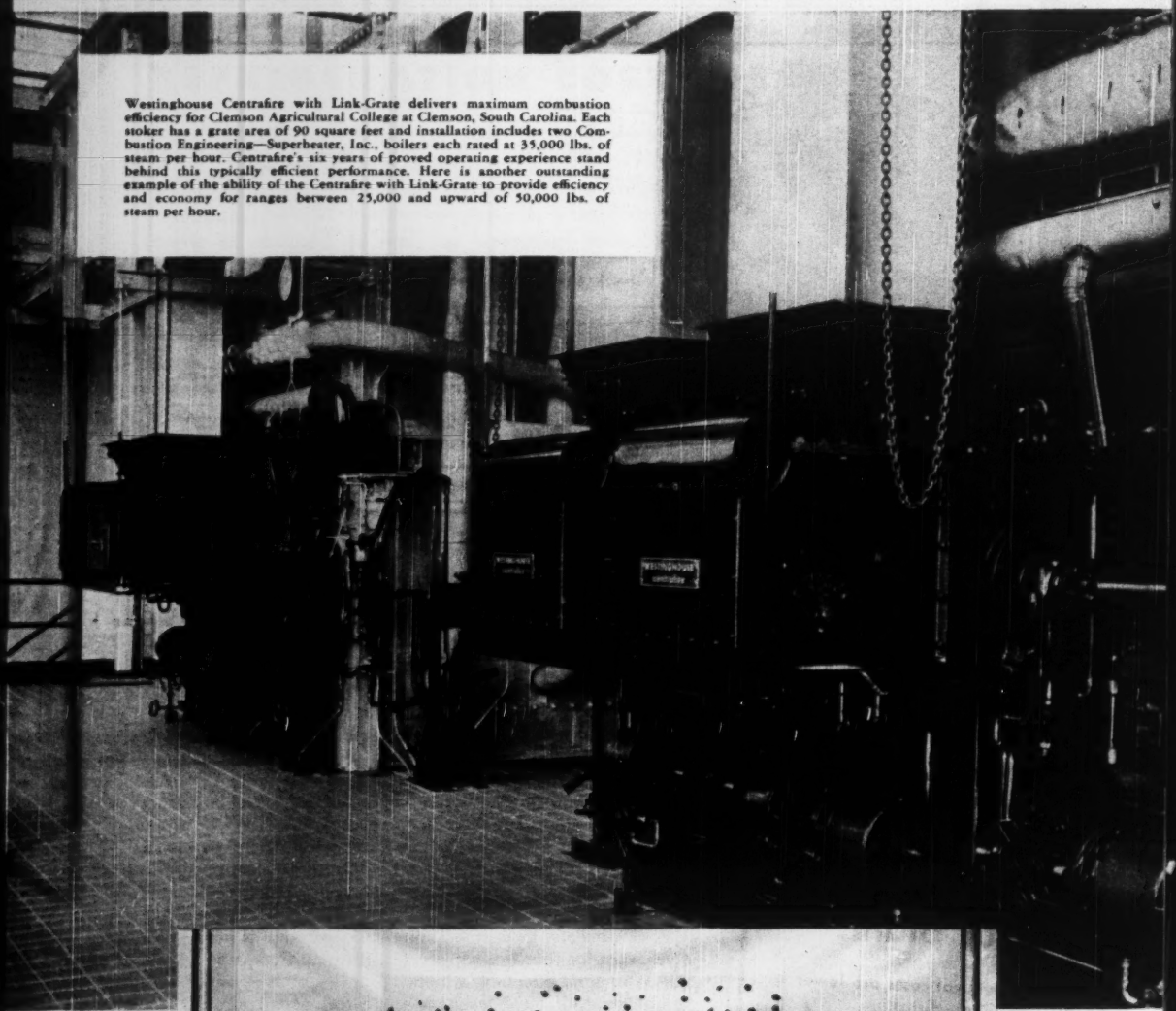
A new bulletin giving more information about this process is available. Write for your free copy to The Permutit Company, Dept ME-9, 330 West 42nd Street, New York 18, N. Y., or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

Permutit®

WATER CONDITIONING HEADQUARTERS FOR OVER 37 YEARS

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



Westinghouse Centrafire with Link-Grate delivers maximum combustion efficiency for Clemson Agricultural College at Clemson, South Carolina. Each stoker has a grate area of 90 square feet and installation includes two Combustion Engineering—Superheater, Inc., boilers each rated at 35,000 lbs. of steam per hour. Centrafire's six years of proved operating experience stand behind this typically efficient performance. Here is another outstanding example of the ability of the Centrafire with Link-Grate to provide efficiency and economy for ranges between 25,000 and upward of 50,000 lbs. of steam per hour.

CENTRAFIRE with *Link-Grate*

High Thermal Efficiency

comes in small packages, too!

Centrafire with Link-Grate is specifically designed for capacities ranging from 25,000 to upward of 50,000 lbs. of steam per hour. Unique spreader-type firing and continuous Link-Grate action provide traveling-grate performance at considerably less initial cost. Centrafire's years of proved operating experience are your assurance of its ability to deliver maximum combustion efficiency. The design and construction refinements that make this efficiency possible are built in, not added as extra accessories.

Link-Grate motion keeps the burning fuel in constant progression, forming a porous bed that burns evenly and thoroughly. An undulating wave-like motion keeps ash accumulation small in size. Coal is not spread over the ash-discharge section. Ash is discharged without interruption of fuel feed or air flow.

Before making another stoker investment, be sure you have complete information about Centrafire with Link-Grate that gives you these proved points of superiority: Discharges ash without reduction of capacity . . . Precisely arranges fuel, air and gases for high thermal efficiency, maximum combustion . . . Feeds coal evenly . . . Fires any grade of bituminous coal . . . Distributes coal uniformly . . . Basement not required; ash can be collected on same level.

J-50514

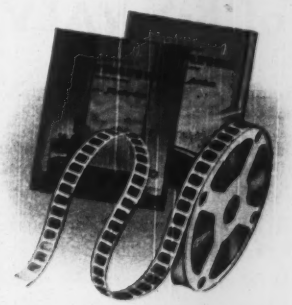
GET THESE FACT-PACKED BOOKS: The complete Centrafire story, including performance facts and economy figures.

CENTRAFIRE with Link-Grate, B-3890-A
CENTRAFIRE with Traveling Grate, B-4553

Write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

SEE LINK-GRATE MOVIE IN YOUR OWN OFFICE

A 10-minute, 16-mm. sound movie that gives visual proof of Centrafire's ability to deliver precision combustion. Call your nearest Westinghouse Steam Specialist for a showing.

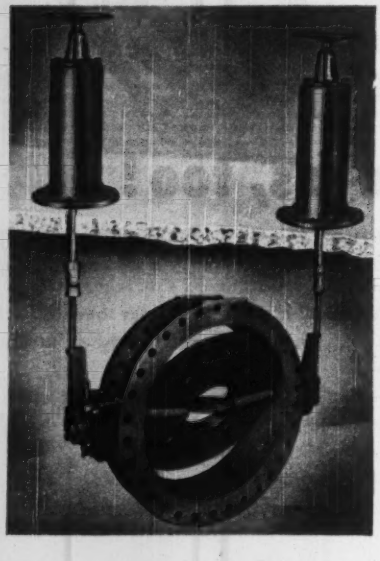


Westinghouse

STOKERS

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



No. 727

36 inch x 8 inch heavy duty dual valve with 125-pound Am. Std. flanges controls maximum flow with a small pressure drop in large 36-inch valve. By closing large valve, small inner 8-inch valve controls small flow with high pressure drop. Separate handwheel controls for each valve vane patented. Automatic control and drip tight rubber seat available.

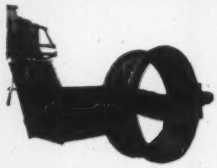
7 Advantages of R-S VALVES

1. Economy in first cost. Minimum number of working parts.
2. Body assemblies correctly engineered mechanically and metallurgically. Equal or exceed A.S.A. standards in every detail.
3. Only a few handwheel turns required for opening or closing.
4. Less inherent pressure loss reduces pumping costs.
5. More control rangeability. Readily adapted to automatic operation.
6. Self-cleaning—no pockets to capture sediment—no objectionable turbulence or wire drawing.
7. Rotary motion of shaft reduces stuffing box problems.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.

No. 680—Standard heavy duty valve with handwheel control—self-locking worm and gear. Automatic control and rubber seat available with 125-pound flanges. Rubber seated valves are drip tight with water at 100 psig and air bubble tight at 80 psig under temperatures up to plus 275° F. and as low as minus 40° F.

No. 771—Heavy duty water type valve equipped with handwheel control—self-locking worm and gear. One-piece body casting. Vane, shaft assembly and handwheel control identical with double flanged valve. Face-to-face dimension does not reduce torque. Flareout on body casting accommodates large mounting bracket base same as No. 680.



No. 734—72 inch 125 pound "H" metal valve for 800° F. Equipped with cooling fins, oil cylinder and positioner utilizing 200 psig operating oil pressure and 0-15 psig instrument air. Positioner cam driven simulating straight-line semi-log control curve or other characteristics if desired.

R-S field representatives maintain experienced engineering and maintenance staffs to study your valve problems, make recommendations and an appraisal of what you may expect from such studies. Specially trained factory representatives are also available for consultation.
Consult with your local R-S representative. Look for the address and phone number listed under "R-S Products, Valves" or write direct.

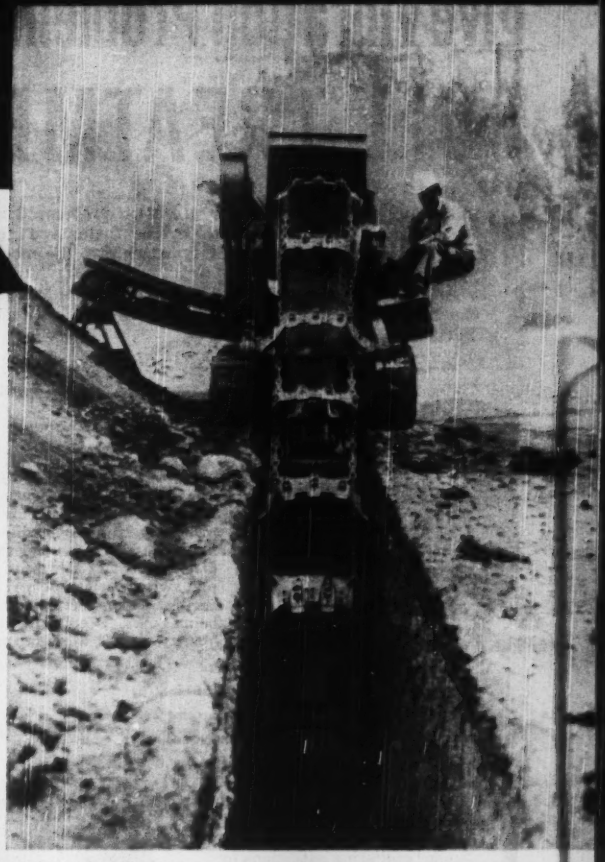
Faster Ditching...Greater Versatility

BUCKEYE 406

GENERAL UTILITY DITCHER

Another Cost-Cutting Application of

VICKERS HYDRAULICS

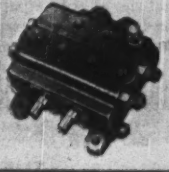


The Model 406 is a prominent member of the family of Buckeye Ditchers described as providing "The Most Ditch for the Least Money." It has a reputation for fast digging, stamina and versatility. The telescoping boom provides digging depths down to 6′ to 8′; cutting widths are from 17″ to 24″. Being exceptionally compact, the 406 works in close quarters as well as in the wide open spaces.

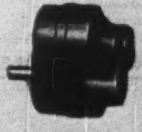
Vickers Hydraulics has an important part in the performance of the 406. The boom hoist is driven by a Vickers Hydraulic Motor which provides positive control at all times . . . boom cannot float or sink in ditch. Raising or lowering of boom is easily accomplished. Another Vickers Hydraulic Motor quickly shifts the conveyor from the extreme position on one side of machine to the other (or any intermediate position). When working under close or irregular conditions, this feature is invaluable in gaining clearance. The Vickers Pump shown also supplies power for the hydraulic brakes.

Vickers Hydraulics improves the operation of a great variety of construction machinery. Get in touch with the nearest office for information and data on Vickers hydraulic equipment designed and built expressly for construction machinery and information on other cost-cutting applications.

Vickers Double Pump consists of two vane type pumps driven from same shaft . . . providing power for two separate hydraulic circuits. Exclusive "hydraulic balance" construction assures longer pump life.



Vickers Sectional Type Multiple-Unit Valve is available in many combinations for convenient and selective control. Includes relief valve for overload protection.



Vickers Gear Type Hydraulic Motor has complete hydraulic balance (both radial and axial) that eliminates pressure loads, thus providing longer life, higher operating efficiency, greater practical operating pressure.

VICKERS Incorporated

DIVISION OF THE SPERRY CORP.

1500 **OAKMAN BLVD.** • **DETROIT 32, MICH.**

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • MILWAUKEE NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER ROCKFORD • ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

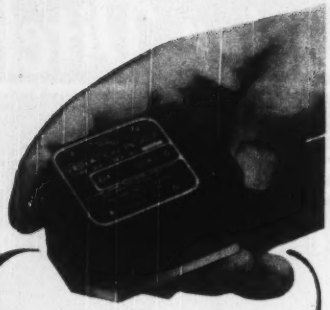
4142

With **MB** products, of course, you can

give Vibration Problems the FULL TREATMENT

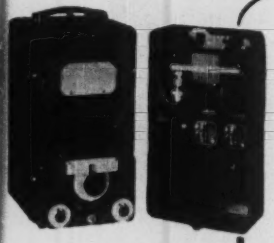
One thing is sure about your vibration problem. The more "tools" you have to deal with it, the faster you get your answers, the better the results you achieve, the more work you save.

And here is the equipment for the job. These MB products can help you in the four essential phases of vibration control work.



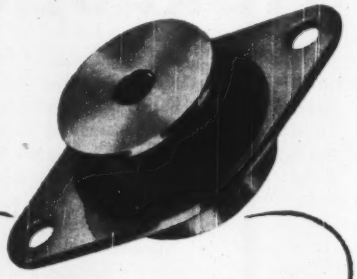
DETECTION:

The MB Vibration Pickup has practically no lower limit on amplitudes to which it responds. It stands up in heavy duty work as well. It converts vibratory motions to electrical voltages which can be measured by the meter.



MEASUREMENT:

The improved MB Vibration Meter interprets the nature of vibration picked up. It gives you direct readings on velocity, acceleration or displacement of vibration by simple switch selection. A rugged, accurate and portable unit, it is being used effectively both for quality-control work and research.



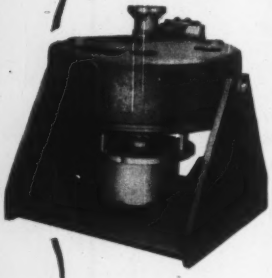
CONTROL:

Many engineers now know that Isomode* Mounts not only simplify designing, but provide superior isolation as well. Possessing equal spring rate in all directions, these units absorb vibration in all planes, and may be installed at any angle. They have high load capacity in small size. Also unusual stability for their softness, and self snubbing feature for overloads.

*Trade-Mark Reg. U.S. Pat. Off.

EXCITATION:

Want to know how your product will fare against vibration? Then subject it to vibration simulating that found under operating conditions by means of an MB Vibration Exciter. Within *minutes* or *hours* see the effect of *years* of vibration on your product. Available in forces of from 10 to 300 pounds, MB Exciters can fatigue-test products ranging from electron tubes to heavy axle shafts.



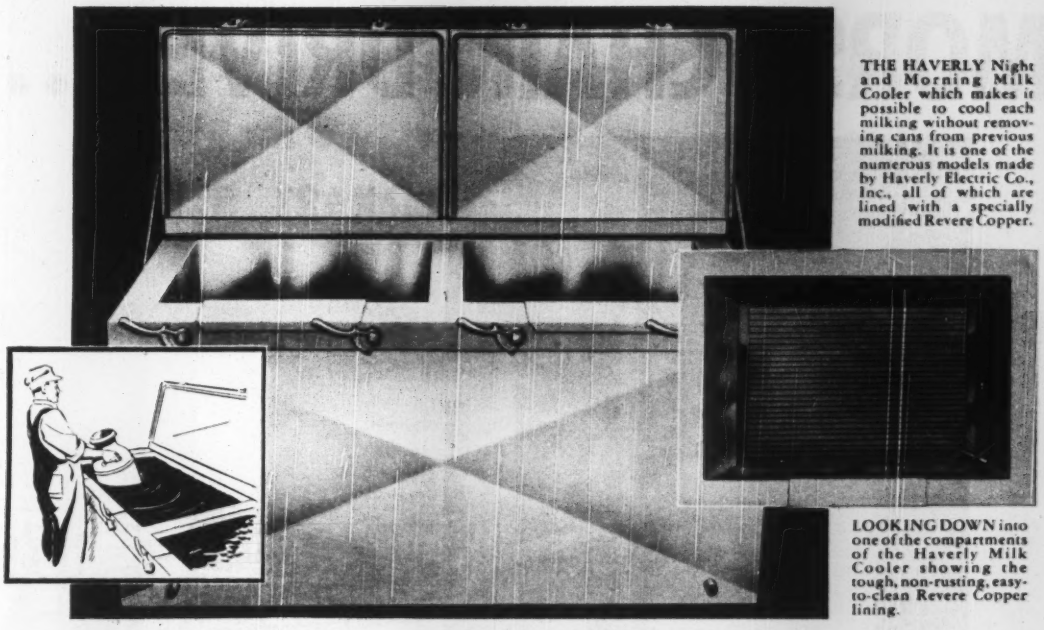
Get a more complete picture on your own vibration problems by doing what so many companies have found to be good practice – make MB your headquarters for vibration control information.

More data and bulletins on any of these products are yours for the asking. Write to Dept. L4

THE MB MANUFACTURING COMPANY, Inc.

1060 State St., New Haven 11, Conn.

PRODUCTS FOR MEASUREMENT . . . REPRODUCTION . . . AND CONTROL OF VIBRATION



THE HAVERLY Night and Morning Milk Cooler which makes it possible to cool each milking without removing cans from previous milking. It is one of the numerous models made by Haverly Electric Co., Inc., all of which are lined with a specially modified Revere Copper.

LOOKING DOWN into one of the compartments of the Haverly Milk Cooler showing the tough, non-rusting, easy-to-clean Revere Copper lining.

HOW COPPER, THE RIGHT COPPER

Increased Sales

OF HAVERLY MILK COOLERS

On farms throughout the country mechanical refrigeration for the cooling of milk has been growing by leaps and bounds. Late in 1945, there were many complaints from the farmers regarding the war-quality rustable material used to line these milk coolers. They were difficult to clean and were rusting out rapidly.

When restrictions were lifted on copper and copper alloys, the Haverly Electric Co., Inc., Syracuse, N. Y., came to Revere to see if non-rusting, easy-to-clean copper could be used. The solution was not as easy as it sounds. For the copper, in addition to its non-rusting and high thermal conductivity properties, also had to be strong enough to withstand the constant banging of 80-lb. cans of milk, and at the same time sufficiently ductile for easy fabrication.

Two Revere sheet metal specialists and their staffs went to work. Tests showed electrolytic copper was not mechanically feasible. Then tests were run with several modified coppers. One of these was found to possess *all* of the requirements.

This use of copper as a liner for milk coolers further resulted in the development of the Haverly "Floating Ice" feature. The ice forms on the side walls of the smooth copper liner; works loose and floats to the surface, adding cracked ice cooling around the top of the can at the cream line, where fast and efficient cooling is needed and proves most profitable. Hence a more efficient unit. Also, due to copper having the highest heat-conductivity of any other commercial metal, copper cooling coils are attached to the outside of the copper lining. This results in greater cooling efficiency and easier cleaning. Here again Revere helped. The Revere welding department developed a fast method of attaching this Revere Dryseal Copper Tube to the lining.

The final outcome is that sales of the Haverly Electric Co., Inc., have increased until they are selling all they can produce of this type cooler, while the mutual knowledge gained has resulted in this company expanding its use of special copper alloys in coolers for other industries.

Perhaps Revere can be of help in developing or improving your product, increasing your sales. Why not call the Revere Sales Office nearest you next time you have a problem in metals?

REVERE

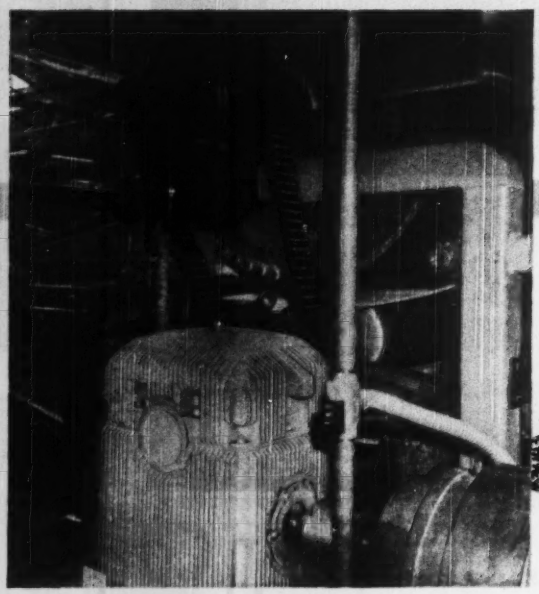
COPPER AND BRASS INCORPORATED

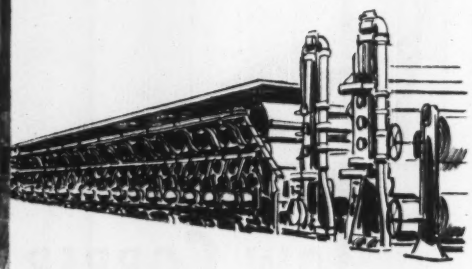
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere

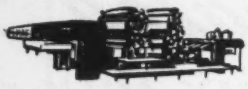
MORSE CHAIN DRIVES...





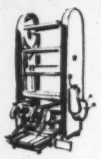
MORSE PRODUCTS ARE USED ON ALMOST EVERY POWER TRANSMISSION JOB

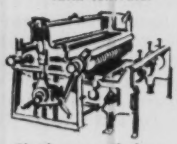
Roller chain drive on farm cultivator



Clutch on offset printing press

Roller chain drives on candy tray handlers





Clutch on needle loom

Timing chains for automobiles

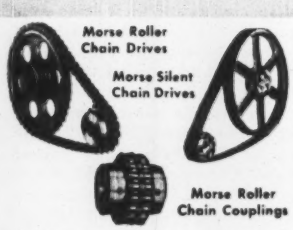
Drive chains and hoist chains on industrial lift truck

Couplings on television transmitters

Ask the Morse Man for power transmission information!

100 Morse Branch Offices and Distributors to supply your power transmission demands.

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under **"Power Transmission"** or **"Chains"** for the nearest Morse Man.

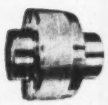


Morse Roller Chain Drives

Morse Silent Chain Drives

Morse Roller Chain Couplings

Morse Silent Chain Couplings



Morse Morflex Radial Couplings

. . . . solved a paper problem and they may answer your POWER TRANSMISSION problems, too!

WHEN a Philadelphia engineering firm had the problem of getting a sufficiently powerful drive into a limited space to drive a paper drier in a large paper mill, a Morse Roller Chain Drive helped provide the solution.

A 50 h.p., 1150 r.p.m. motor was required to drive the drier through a 40 to 1 speed reducer. To handle the load with reasonable safety, a worm-geared reducer of 21-inch center distance would have been required . . . a tight fit in the space available.

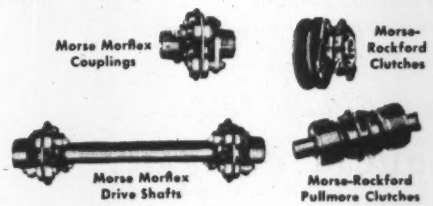
The engineers finally did the job with a standard reducer of only 12-inch center distance, greatly reducing the cost of the installation. A triple width Morse Roller Chain Drive of 2.06 to 1 ratio connected the reducer output to the drier shaft.

Applications in Every Field

Morse Roller Chain Drives solve similar problems every day in countless fields. They are 99% efficient; use teeth, not tension; can't slip, yet are extremely flexible. Morse Roller Chain is adaptable to tough power transmission jobs, large or small. Apply the basic formula M = PT to your design, development or engineering problems. You'll find Morse your answer.

M=PT
BASIC FORMULA

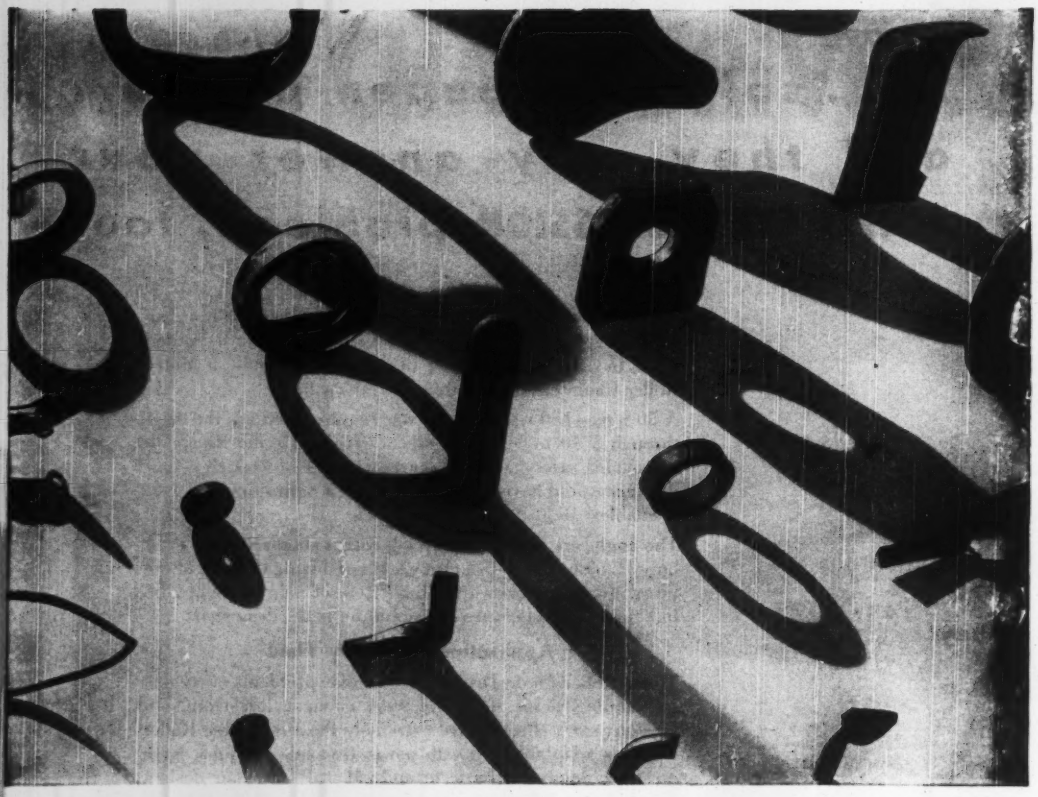
Morse *means* Power Transmission



MORSE
MECHANICAL
POWER TRANSMISSION
PRODUCTS

Morse Chain Company, 7601 Central Ave., Detroit 8, Michigan

BW



ENGINEERING in cellular rubber that keeps pace with your *imagination*

In some minds Spongex cellular rubber is a vibration pad for huge hydraulic presses, to others it is a powder puff. For other thousands Spongex is of a density and compression range that was especially compounded to do their job best. There seems to be no limit to man's imagination in creating new uses for Spongex.

In serving man's creative mind our laboratory has formulated over 60,000 recipes for cellular rubber. Each applies one or more of the known qualities of Spongex to insulate against shock, vibration, sound, air and temperature.

In every industry there exist problems that Spongex may solve. Whenever your thoughts are on vibration, insulation, cushioning, gasketing, sealing or sound damping, think about Spongex. It can be your biggest help.

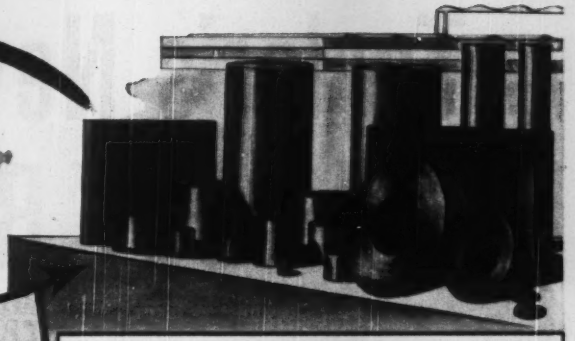
Spongex cellular rubber is available in molded shape or die cut form — or in sheets, slabs, strips, cord, tubing, or bonded to metal or fabric.

Write for *Technical Bulletin on Sponge Rubber* today.

The World's Largest Specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY
301 DERBY PLACE SHELTON, CONNECTICUT

NOW... Right at Your Doorstep*



BOST-BRONZ
Oil Impregnated
All-Purpose
POROUS BRONZE
BEARINGS
with Oil Film Always Present All Over

with FIVE
Outstanding Advantages:

1. **BOST-BRONZ Bearings carry their own lubrication.** The oil cushion adds to life and to load capacity.
2. **BOST-BRONZ Bearings save money.** No oil holes or grooves to machine. Longer service.
3. **BOST-BRONZ Bearings are quieter and cleaner.** An oil film to start on and to run on. No oil drip or waste. No openings for grit, lint or dirt.
4. **BOST-BRONZ Bearings are easy to assemble and size.** Simple press fits without machining. Available in wide range of sizes, *from stock.*
5. **BOST-BRONZ Bearings have the quality and precision for superior performance.** They can be applied with confidence to heavy loads, light loads, high speeds, low speeds, static loads and shock loads.

BOSTON *Gear* stocks are *Near*

FOR QUICK, COMPLETE INFORMATION ON BOST-BRONZ BEARINGS

sizes, prices, tolerances and load ratings, see Boston Gear Catalog No. 55. Write for copy of this valuable reference catalog and data book, and for the location of your nearby stock.

STOCKED IN 6 TYPES — CYLINDRICAL BEARINGS, FLANGE BEARINGS, THRUST BEARINGS, CORED BARS, SOLID BARS AND PLATE STOCK — AT YOUR NEARBY BOSTON GEAR DISTRIBUTOR'S — 85 COMPLETE STOCKS IN NORTH AMERICA

BOSTON GEAR WORKS

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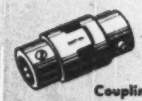
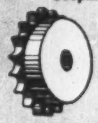

Couplings

Universal Joints


Sprockets

Reducers

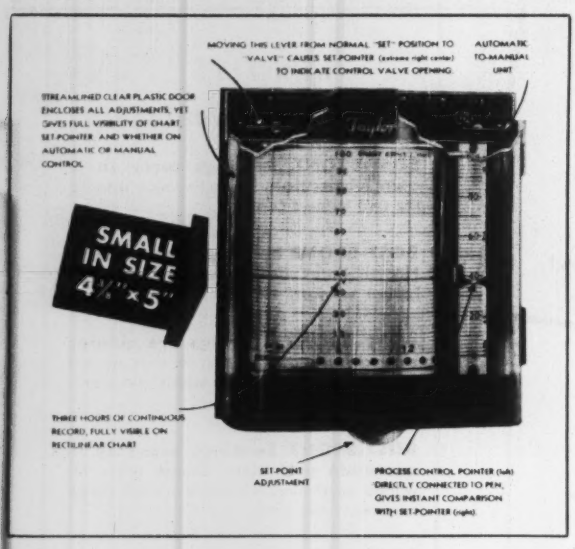
Pillow Blocks

Ratiometers

Bearings

Gears

Taylor's New Midget TRANSET* RECORDER


MOVING THIS LEVER FROM NORMAL "SET" POSITION TO "VALVE" CAUSES SET-POINTER (extreme right center) TO INDICATE CONTROL VALVE OPENING.
AUTOMATIC TO-MANUAL UNIT
STREAMLINED CLEAR PLASTIC DOOR ENCLOSES ALL ADJUSTMENTS, YET GIVES FULL VISIBILITY OF CHART, SET-POINTER AND WHETHER ON AUTOMATIC OR MANUAL CONTROL
SMALL IN SIZE 4⅜"x5"
THREE HOURS OF CONTINUOUS RECORD, FULLY VISIBLE ON RECTILINEAR CHART
SET-POINT ADJUSTMENT
PROCESS CONTROL POINTER (tab) DIRECTLY CONNECTED TO PEN, GIVES INSTANT COMPARISON WITH SET-POINTER (right)

Gives continuous 30-day chart record on 4⅜" x 5" panel space

PLUS

1. **Automatic-manual unit**
2. **Remote set-point adjustment**
3. **Valve position indication**
4. **Chart re-wind mechanism (optional)**

THIS tiny (4⅜ x 5") pneumatic TRANSET RECORDER for flow, liquid level, pressure and temperature, greatly simplifies the most complicated central control problems. It indicates and records in the same space required by a conventional-sized indicator alone. And it eliminates receiver wings on even the most up-to-date central control panels (particularly graphic panels).

HERE ARE A FEW UNIQUE ADVANTAGES:

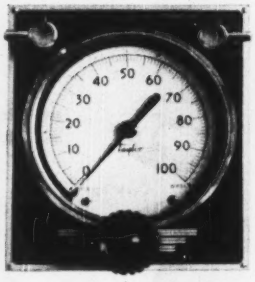
1. ***Easily removable chart-drive mechanism for re-loading.***
2. ***Scale shows actual transmitter process range —is graduated 3-15 psi. for checking calibration and valve position.***
3. ***Automatic-to-manual feature gives easy start-up—makes it easy to service controllers.***

You Can Get These Four Models: **(1)** One process record, set-point indication, set-point adjustment, valve position indication, and automatic-to-manual unit. **(2)** One process record, valve position indication, and remote manual valve loading. **(3)** One process record only. **(4)** Transet Indicator (below).

For Complete Details, Send for Bulletin 98079. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

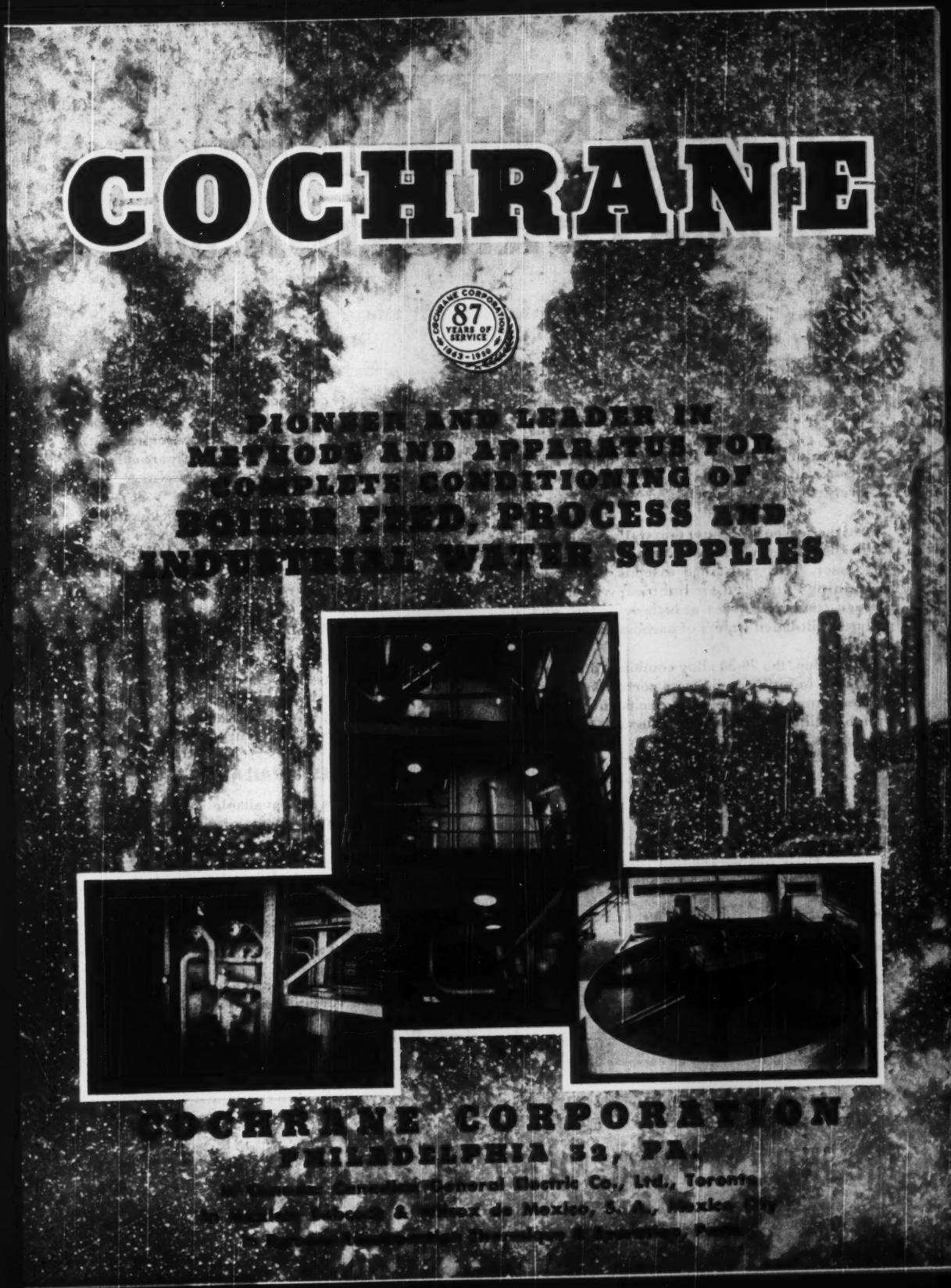
TRANSET INDICATOR

Fits into the same panel cut-out as TRANSET RECORDER. Many parts interchangeable with TRANSET RECORDER. Available with or without Automatic-Manual and remote control point setting.



*Reg. Trade-Mark

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST


COCHRANE
COCHRANE CORPORATION
87 YEARS OF SERVICE
1863 - 1950
PIONEER AND LEADER IN
METHODS AND APPARATUS FOR
COMPLETE CONDITIONING OF
BOILER FEED, PROCESS AND
INDUSTRIAL WATER SUPPLIES
COCHRANE CORPORATION
PHILADELPHIA 32, PA.
In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City
In Portugal: Companhia Thermique & Equation, Paris

Put CUPRO-NICKEL in to keep CORROSION out

Aship and ashore, vital metal parts of many types of equipment often operate under conditions exposing them to salt water corrosion. And that's where cupro-nickel alloys prove their worth . . .

In fact, during World War II, all available 70-30 copper-nickel condenser tubes were reserved exclusively for Naval vessels and tankers.

And the reason? Because thin walls of this strong, tough alloy resist corrosive and erosive attacks from salt water. This resistance extends to sea water containing entangled air bubbles, which passes through condenser tubes at high velocities, and to polluted, silt-laden waters of harbors and estuaries.

In addition, the 70-30 alloy combines outstanding resistance to pitting and stress corrosion cracking, plus maximum resistance to dezincification, together with the ability to withstand a wide variety of corrosive agents.

The International Nickel Company, Inc.
Dept. ME, 67 Wall St., New York 5, N. Y.

Gentlemen:

Please send me additional information about cupro-nickel alloys.

*Name*_____ *Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

APPLICATIONS

Ocean-going ships equipped with cupro-nickel condenser tubes and piping can travel hundreds of thousands of miles and many years longer without layovers for tube replacement . . . a particularly important advantage for merchant vessels.

But that is only one example. Cupro-nickel alloys have established outstanding service records in applications ashore as well as at sea. They serve in sugar mills, oil refineries and power plants . . . in vital parts of feed water heaters, condensers, evaporators and other heat exchangers . . . in oil coolers, stills, water boxes, piping, tanks, and other equipment.

Cupro-nickel alloys eliminate those hidden taxes on profits represented by maintenance, replacement expense, loss of heat transfer capacity and interruptions of operation resulting from corrosion.

TYPES AVAILABLE

Cupro-nickel alloys are available in many types containing various percentages of nickel. The most widely used for condenser tubes and marine shore station applications is composed of 70% copper and 30% nickel. Another which is gaining wide acceptance is the new iron modified 90-10 cupro-nickel.

Cupro-nickel is available as tubing, rod, strip, wire and sheet, and also in cast form.

We shall be glad to give you additional information about these versatile cupro-nickel alloys and help you select the one best suited to your requirements. Write us today.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 72 NUMBER 9

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Cantilever Constructed Research and Development Tower

(With a screen of weather sheeting serving as protection, the new cantilevered research building for S. C. Johnson & Son Inc., at Racine, Wis., is shown in process of construction. *For futher details see page 739 of this issue.)*

VOLUME 72
No. 9

MECHANICAL ENGINEERING

SEPTEMBER
1950

GEORGE A. STETSON, *Editor*

World Power Conference

SINCE the first World Power Conference was held in London in 1924, the world has witnessed extensive and confusing changes. A quarter of a century ago the western world was attempting to recover from the shattering results of a great conflict and many parts of it were caught in an industrial depression which soon afterward laid its numbing hand on the United States. The old prewar conditions in practically every area of human affairs were giving place to new ones. Social, economic, political, as well as technological forces were at work, and although many persons still hoped for a return of the long years of peace and progress that had been the pattern of prewar years, their hopes were not to materialize as they had been formed. A new world conflict was in the making, and the tempo of change in all areas was accelerating. The second world war broke with even more devastating effect, and although the fighting finally ceased and men looked forward once more to an era of peace, recovery, and rehabilitation, the atmosphere at London, where the Fourth World Power Conference was held, July 10 to 15, 1950, was charged with apprehension caused by the outbreak of hostilities in Korea. But in the engineer's special field of power, steady and substantial progress was unquestioned.

A rough and hasty comparison of conditions as they existed in 1924 and 1950 would reveal, in a large portion of the western world, a decided trend toward socialism, which, in the older democracies, has taken the form of greater economic security for the common man, the extension to him of tax-supported benefits in almost every area of his life, accompanied by the extraordinary rise of the power of labor, the nationalization of industries and undertakings on which modern living is firmly based, and more rigid control of the individual by governments. In some nations these same influences, directed by a contrasting philosophy, and controlled by minority groups which have successfully isolated the minds of people from ideas and conditions existing outside the borders of their own lands, have also been at work. And in other parts of the world, economically and socially backward in the western sense, great unrest has created an atmosphere in which both philosophies of the relationship of the individual to the state, the western and eastern European, are attempting to win over the minds of men.

These economic, social, and political forces are powerful and in active opposition to one another. It is all the more striking by contrast, therefore, that the fields of science and engineering follow a common pattern with common results in the development of our knowledge of the physical world. Hence a comparison of the state of the art and knowledge of technology, a quarter of a century ago and now, reveals not different fundamental approaches and results but similar ones. If it made anything clear, the World Power Conference did this. And it raised in the minds of everyone present the hope that this universality of science and technology, based as it is on something more positive and fundamental than the moods and notions of men, may be one influence in a progress toward peace and better living for peoples all over the world.

Working toward a single goal as science and technology do, instead of different and conflicting goals as dominant political philosophies apparently do, progress in engineering in the last quarter century has been rapid and noteworthy. Even though war itself proved to be one of the greatest stimuli ever experienced in putting scientific discoveries into use for mankind, there are few examples of that progress to be found that do not have as great a promise for peaceful as for military uses. In the field of power that concerned the London conference, for example, an assay of important developments reveals rapid progress in the gas turbine, the rocket engine, the heat pump, and atomic power, all comparatively recent, and in metallurgy, without which none of this substantial progress would have been possible. Developments in metallurgy have made practicable the use of higher temperatures and pressures in power-generating equipment and hence increases in the more efficient use of sources of energy, a goal toward which engineering must continually strive if it is to increase the power available for the world's work without exhausting its resources. Striking testimony was offered at the Conference of the greater reliability of equipment and hence the greater availability of power, a factor in itself that increases efficiency and aids conservation.

Because Nature has not distributed evenly over the face of the earth the great sources of energy—coal, oil, gas, and water power—the technological and economic factors with which nations have to contend, and hence the direction of their engineering developments, are markedly different. North America is blessed with all of these sources of energy in great abundance, and with conditions which make the sharing of its resources a simple matter, economically and politically. Hence the contrast with conditions prevailing in some other parts of the world is striking. Great Britain and Europe combined have similar resources, but because of national boundaries and political conditions, security demands development of whatever power resource may predominate locally. Hence in nations which have little

or no coal, oil, or gas, energy derived from thermal sources demands development of low-grade and substitute fuels; and, in some cases, where geological conditions are favorable, energy is derived from subterranean heat. Hydroelectric power predominates in other countries which lack fuels. A World Power Conference affords an opportunity for the discussion of all these many sources of power and for a survey of them and progress in their development.

A quarter of a century ago the hope was expressed, and it was re-expressed this year at London, that the interdependence of the nations of Europe on one another for power and energy resources might be a compelling influence for peace. But this hope, the realization of which is long deferred, has not relieved engineers of the urgent necessity of developing the energy resources within their national boundaries. Only in the relatively free exchange of scientific knowledge and engineering experience has much progress been made in this field of international amity.

The Fourth World Power Conference followed the familiar pattern of such international meetings. An opening session, held at the Central Hall, Westminster, on the afternoon of July 10, afforded an opportunity for the chairman of the International Executive Council, Sir Harold Hartley, to read a message of greeting from the Princess Elizabeth in which she said that energy was needed to raise the standard of living all over the world, and that we must use resources with care as they are not inexhaustible.

The technical sessions, of which nineteen were scheduled, were held at the headquarters of The Institution of Civil Engineers, The Institution of Mechanical Engineers, and The Institution of Electrical Engineers. Upward of 150 papers, contributed by engineers from all over the world, were divided into 10 groups of general subjects and were presented in abstract form at the beginning of each session. These papers had been preprinted, in English or in French, and copies were available. The abstracts of all of the 19 sets of papers were also preprinted. They contained some essential parts of each paper and, in general, some suggested topics for discussion. At each session these digests were presented first. Prepared discussion was then called for, after which the authors of the papers, if they were present, were given an opportunity to speak. A general summary of the discussion concluded the session. An excellent translation service made it possible to follow the proceedings in French or English.

Social events were scheduled for the evenings. There were two receptions, one given by His Majesty's Government at the Science Museum, and the other at Guildhall, to meet the Lord Mayor and Lady Mayoress, Sir Frederick Rowland and Mrs. Rowland. A banquet, with customary speeches, at Grosvenor House, was attended by about 1500 persons. A program of entertainment for the women was carried on throughout the week.

At the closing session the chair was taken by Sir Vincent de Ferranti, who succeeds Sir Harold Hartley as chairman of the International Executive Council. Colonel H. S. Bennion, vice-president and managing director, Edison Electric Institute, read a message from Dr. W. F. Durand, president, World Power Conference, past-president and honorary member ASME, to which Sir Harold Hartley, who succeeds Dr. Durand as president, responded by reading a message of reply dispatched to Dr. Durand by cable. Sir Vincent de Ferranti then presented a set of resolutions of thanks which were supported in brief speeches made by representatives of Canada, Russia, Switzerland, Pakistan, Turkey, Belgium, Chile, Austria, Finland, and Ireland. Sir Harold Hartley closed the Conference by saying that it would be memorable for the additions it had made to our knowledge, and that it had strengthened the traditional bonds of friendship which bind members of the Conference together. Following the Conference study tours, lasting from a portion of one day to a full week, were available to members.

No adequate summary of the technical sessions can be attempted in this place at this time, but a general outline of the subject matter discussed will indicate the scope of the Conference. The 26 papers of the first technical session were devoted to a survey of the energy resources of the world, as covered by the Conference, with comparisons of the status as reported at the first Conference in 1924. Sessions were devoted to the preparation of solid, liquid, and gaseous fuels; to the production of steam power, including developments in power-station design, steam generators, turbines and auxiliaries, and miscellaneous fuels; to internal-combustion engines, gas turbines, and jet engines; to water-power resources and location and design of hydro plants; to atomic energy; and to other sources of energy—wind power, subterranean heat, temperature differences at the surface and below the surface of the sea, and the heat pump. Published proceedings of the Conference, including the papers and discussions, will be available at a later date.

What benefits are derived from such a conference as the one held in London? It is obvious that publication of the papers and discussions, with their summary assessments of the current world situation in respect to power and the reports of work done in many lands, will rank as important contributions to engineering knowledge. From the papers presented it is possible to obtain a perspective of the world situation and of the special problems which face the engineers of many of the nations. Emphasis placed by a majority of authors on the need for the conservation of natural energy sources, regardless of the natural advantages enjoyed by any nation, the need to develop low-grade fuels, to increase the efficiency of every energy-conversion process, to attack with renewed vigor the discovery of new sources of energy and energy-conversion devices, should have a fruitful effect on engineers and stimulate their ingenuity and researches. The opportunity afforded members of the Conference for friendly intercourse, and an insight into the special problems faced by engineers of many lands and their means of solution, will deepen the perception and sharpen the wits. So also will firsthand inspection of engineering projects in Great Britain, made possible by the postconference study tours, enlarge men's vision and the circle of their professional friendships.

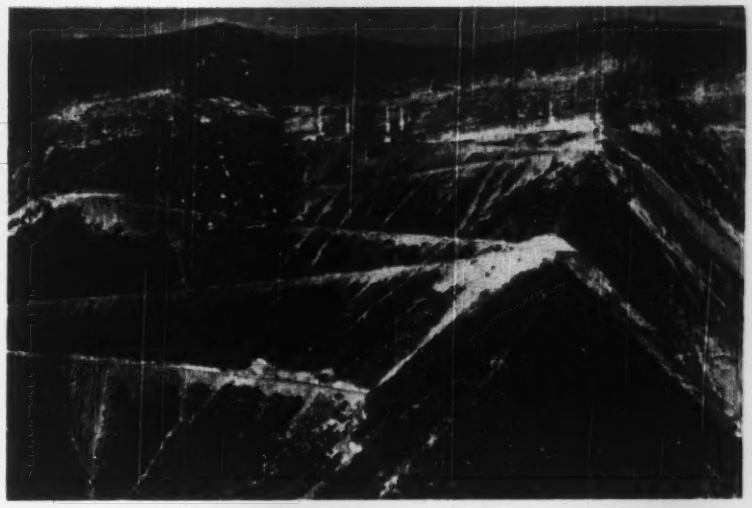

FIG. 1 OIL-SHALE OUTCROP AND MINE SITE

OIL-SHALE MINING

*Innovations in Equipment and Underground Procedures at Rifle, Colo.**

By E. D. GARDNER[1] AND E. M. SIPPRELLE[2]

AS A PART of the Synthetic Liquid Fuels Act (58 Stat. 190, 30 USC Secs. 321–325), the Bureau of Mines has developed an underground mine near Rifle, Colo., to demonstrate methods of and establish costs for mining oil shale on a commercial scale.

CHARACTER OF THE MINE AT RIFLE

The oil-shale mine is on Naval Oil-Shale Reserve No. 1 and is about 5½ miles by mountain road from the plant site which, in turn, is 2 miles from U. S. Highway 6, and 10 miles from Rifle, Colo. The highway parallels the Colorado River, the Denver & Rio Grande Western Railroad, and a 66,000-volt public-utility power line.

The principal oil-shale measure, Fig. 1, is 500 ft thick, contains an average of 15 gal of oil per ton, and extends over an area of 1000 sq miles. The lower 70 ft, known as the Mahogany Ledge, which now is considered to have economic importance, outcrops at the base of a long line of cliffs 3000 ft above the valley floor. The Mahogany Ledge at the oil-shale mine contains 0.7 bbl of oil per ton; it lies nearly flat, is not faulted, and has no local rolls.

The deposit is remarkably persistent, as shown by 145 miles of outcrop, and a limited number of core holes back from the outcrop. The principal oil-shale measure is estimated to contain 300 billion bbl of oil in the 1000-sq-mile area. About 100 million barrels of oil shale can be obtained from the Mahogany Ledge per square mile, with allowance for mining losses.

The oil shale is a strong tenacious marlstone. The roof stone overlying the Mahogany bed is a low-grade bed of oil shale that is stronger than the rock of the Mahogany bed. A distinct parting on a bedding plane occurs between the roof stone and the Mahogany Ledge. Another parting occurs 27 ft below the roof stone.

At the beginning of present operations, little was known of the physical characteristics of the oil shale at the site chosen for the mine except what could be gained by observing the cliff. About 6000 tons of oil shale had been mined, however, in 1926 and 1928 about 7 miles westward. One nearly circular room in the Mahogany Ledge, about 50 ft diam, has stood throughout the intervening 20 years with no sign of failure, except some peeling of a 6-in. layer from the roof.

LOW DEVELOPMENT COST AN ESSENTIAL FACTOR

As the value of the oil that could be extracted from 1 ton of oil shale is relatively low, it was recognized at the start that an unusually low over-all mining cost must be attained for an oil-shale enterprise to be commercially successful. Block-caving and methods of mining with haulage levels below the ore measure were ruled out, as the development costs would be too high for the tonnage that could be mined in the Mahogany Ledge. It was decided to mine the Mahogany Ledge by a room-and-pillar method, based largely upon practices in under-

* Work completed on Manuscript M2-1, 1950.

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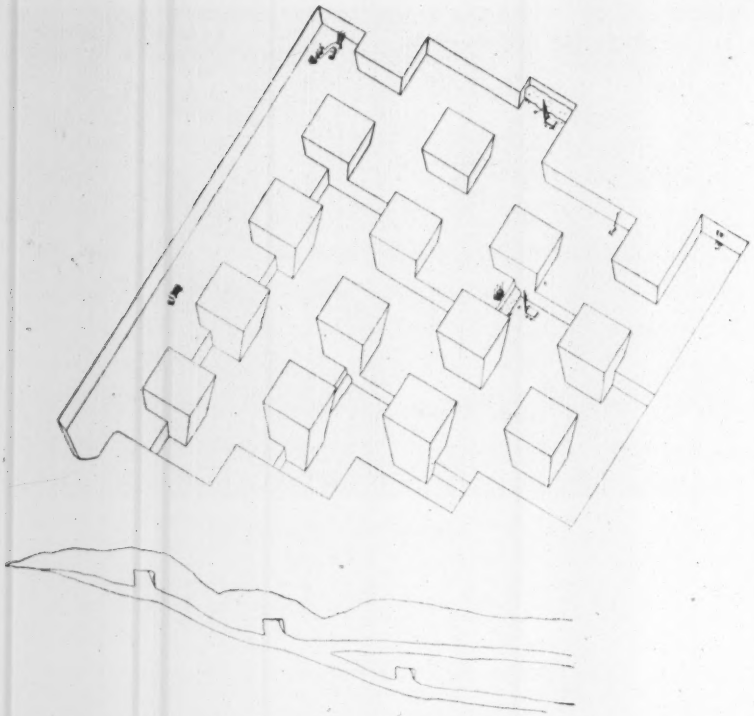

FIG. 2 UNDERGROUND OIL-SHALE QUARRY

ground limestone mines in the Mississippi Valley. In a large-scale operation, the stone would be mined in three levels with the advance heading at the top, Fig. 2. The two lower levels would be similar to benches in a quarry. The advance heading at the top is an innovation. By this procedure, blast holes can be drilled parallel to the roof stone and far enough away so as not to shatter it. Moreover, the roof and the upper parts of the pillars could be made safe more easily from a top level than from a lower one.

The first problem was to ascertain how wide rooms might be to stand safely unsupported, and the size of pillars that would be required to support the overlying formation (about 600 ft). The problem was first attacked from the theoretical side. Representative samples of the Mahogany Ledge and of the roof stone were tested at the Barodynamic Laboratory of Columbia University, and in the Applied Physics Laboratory of the College Park, Md., station of the Bureau of Mines. Different but analogous methods of solving the problems were followed at the two laboratories, but both arrived at virtually the same answers. The results indicated that the roof stone would stand safely in 60-ft spans, and one fourth of the ledge would be required to support the overlying formation.

Representative samples of the roof stone were tested rigidly at the Pittsburgh Station of the Bureau of Mines to ascertain the effects of moisture and drying out. The tests indicated that moist air or dry air of ventilation currents would have little or no effect upon the roof stone.

The theoretical approach to a mining problem seems to be an innovation in this country. The danger of projecting the results beyond the limits of the area tested is recognized. The quality of the roof stone, however, is so remarkably consistent that it is felt the data are reliable for conditions at the oil-shale mine.

A test room 50 × 100 ft in breadth and length and 9 ft in height was run under the roof stone in December, 1946, to verify the theoretical results. It was widened to 60 ft in May, 1947, to 70 ft in August, 1947, and to 80 ft in November, 1948. Measurements of sag of the roof are made daily, Fig. 3. The total sag to April, 1950, was 0.5 in., well within the elastic limits of the stone. There has been no evidence of roof failure. Undue stress applied gradually to a rock causes rearrangement of the rock crystals, which causes subaudible rock noises that can be transmitted by a geophone and recorded. Geophones in the roof stone at the four corners of the test room have recorded no noises that would indicate excessive stresses. A physicist on a mine pay roll also appears to be an innovation.

The first headings in the experimental mine were 50 ft wide; but after the test room had stood safely for 1 year at 70 ft, the rooms were widened to 60 ft. There has been no evidence of undue stress in the mine workings. Pillars are 60 ft square and spaced 60 ft apart; they are staggered in one direction. As engineering data obtained on the middle bench should apply equally well to the lower one, present plans do not call for development of the bottom level in the experimental mine.

As the lowest mining costs are those in quarries and open-cut mines, the aim has been to adopt surface practices as far as prac-

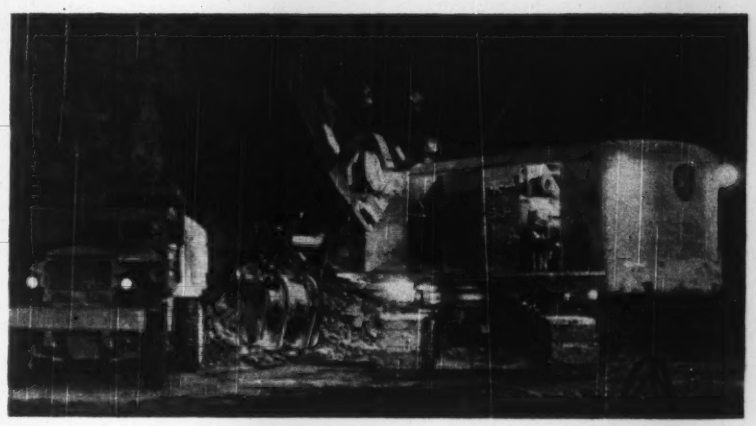

FIG. 4 ELECTRIC SHOVEL LOADING DIESEL TRUCKS IN UNDERGROUND QUARRY

ticable for mining the oil shale underground. The mine is called the "underground quarry." The minimum capacity of a commercial oil-shale mine would be 15,000 tons daily to supply a 10,000-bbl per day refinery. A square mile appears to be a good mining unit. At 15,000 tons per day, the area would be mined out in 20 years, which, in turn, appears to be a good period for use in calculating the life of a mine.

FIG. 3 MEASURING SAG OF ROOF OF TEST ROOM

DEVELOPMENT AND MODIFICATION OF MECHANIZED EQUIPMENT

A goal of a minimum of 100 tons per man-shift for the underground force was set up early in the program. To obtain this objective, the mine would have to be completely mechanized, and the largest units of equipment would have to be employed that would work efficiently in the restricted underground workings. As an investment of $1,000,000 would represent $0.01 per ton to be mined, it was considered that an initial expenditure of this amount could be made to save $0.015 of daily operating cost.

A standard $2^1/_2$-yd electric shovel with a short boom to permit working under a 25-ft height was chosen for loading the broken shale, Fig. 4. As the shale is relatively light in weight (16 cu ft per ton in place), the $2^1/_2$-yd dipper was replaced with one having a capacity of 3 cu yd. Two 15-ton Diesel end-dump trucks were obtained from the Navy, and later a third truck of the same size was purchased for transporting the shale. A study of loading and transportation cycles indicates that 22-ton trucks would be in better accord with the size of the shovel.

Standard equipment was satisfactory for loading and transporting the broken oil shale, but it was evident that it would be necessary to modify conventional drilling and blasting practices to obtain the required tons per man-shift in a commercial oil-shale mine.

Calculations showed that the cost of laying and moving air and water lines on the advancing levels of an underground quarry would be an important item of expense. Moreover, loss of air pressure because of long air lines would reduce drilling speed with pneumatic drills, and the air and water lines would interfere with other work. A movable compressor assembly was designed and constructed under contract. This unit has two 750-cfm compressors, an air receiver, and a water tank, Fig. 5. Air and water lines are not required with this equipment, with resultant saving in operating costs. The compressor motors take the same voltage as the shovel, and the unit can be plugged in the same electrical outlets. A compressor and a shovel would not be working in a heading at the same time. A decided improvement in the drilling rate was obtained when the compressor was put in service.

The original plan was to break the top heading 25 ft high, but after operations were begun it was found that the stone at the bottom broke down to the parting 27 ft from the roof

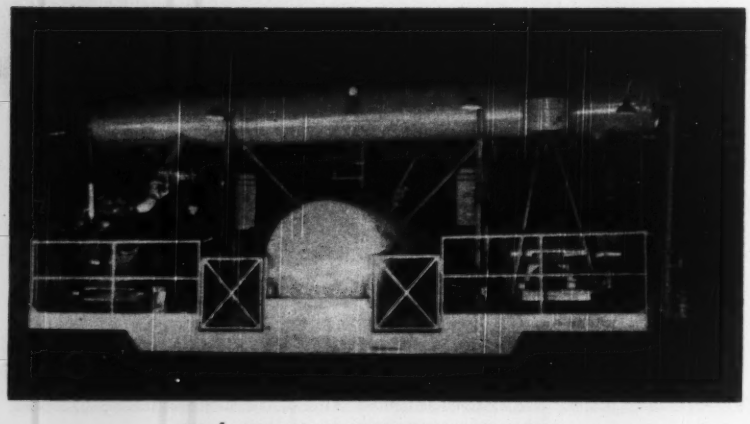

FIG. 5 MOVABLE AIR COMPRESSOR, OIL-SHALE MINE

FIG. 6 MULTIPLE-DRILL CARRIAGE, OIL-SHALE MINE

stone. Drilling horizontal holes 25 ft from the floor presented a new problem. A new and efficient type of multiple-drill carriage (or jumbo), Fig. 6, was designed and built on contract.

This unit has two platforms mounted on a framework at the rear of a Diesel truck. Each platform contains two 4-in. percussion drills mounted on 15-ft feed slides. The vertical inclinations of the feed slides are controlled by screws and ratchets. Air hoists are used for raising and lowering the platform; spur-gear devices permit swinging the platforms to various horizontal angles. A water tank and air-hose reel also are mounted on the truck. Only the 3-in. air hose must be connected to the movable compressor assembly before drilling. The four drills mounted on the carriage are operated by two men. By use of the multiple-drill carriage, two miners drill out a round with 16-ft steel in about 5 hr. An average of nearly 1700 tons is broken per round. The electric shovel, with three trucks, loads it out in a shift.

Before the Bureau of Mines multiple-drill carriage was placed in operation, drilling on the top level was done with conventional wagon drills that required two men to a machine. Over 10 man-shifts were required to drill a 10-ft round with this equipment.

Percussion drills are used for blasthole drilling and may be considered adequate. Rotary drills with tungsten-carbide bits are being tested; they have about tripled the drilling speed of percussion drills, use less power, and are less noisy. Originally the rotary carbide insert bits failed within a few feet. Research to improve the bit design, grade of carbide, and drilling technique has resulted in an increased bit life of 200 ft. Further improvements are expected from current research.

It was seen early in the program that a procedure by which a hole could be drilled with a single piece of steel would speed drilling and reduce the labor required to do the work. Ordinary detachable bits would lose gage in 3 to 5 ft and would have to be replaced. A way of hard-surfacing the bits was de-

vised at Rifle,[3] by which the cutting edge outlasts the bit itself. These hard-surfaced bits were in use for 3 years and averaged over 50 ft of drilling per bit. This bit development made possible drilling 15-ft holes without changes; the jumbo provided the manner of doing it. A smooth-bore hole of the same diameter for its full length also is readily charged with explosive.

After the jumbo was put in operation it was evident that enough consideration had not been given to the drill-rod problem. The cost of broken drill rods amounted to nearly 4 cents per ton of stone broken in a first test run. In a second test, in which commercial bits with tungsten-carbide inserts were used, the cost of drill rods per ton broken was less than 2 cents. According to the manufacturers, the actual time of drilling (200 to 300 min) of each piece of steel before failure, in the first test, was all that should be expected. As all of the drill rods are the same length, broken rods cannot be re-used for shorter changes. Moreover, the cost of broken short changes does not add up as fast as with long rods. Efforts are now being made to find an alloy steel that will have longer life, or to find some manner of treating the steel in use to prevent what is considered excessive breakage.

Loading horizontal holes 25 ft above the floor also presents a problem. A round comprises about 76 holes; it is blasted electrically and is wired with three series in parallel. A special piece of equipment was designed and built for use in charging blast holes on the top level, Fig. 7. As far as known, no similar equipment is used elsewhere. This unit consists of a wooden,

[3] "Development of a Successful Hard-Surfaced Bit for Drilling Oil Shale," by Tell Ertl, J. R. Wagner, Jr., and E. E. Burgh, Bureau of Mines, Report of Investigations 4177, 1948, 8 pp.

FIG. 7 UNIT USED FOR CHARGING EXPLOSIVE INTO BLAST HOLES, OIL-SHALE MINE

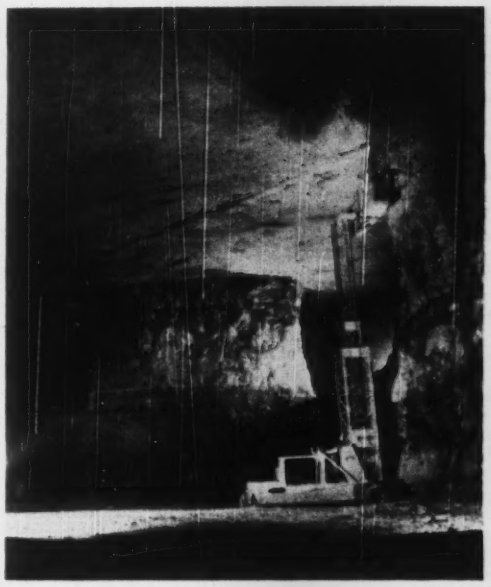

FIG. 8 DEVICE FOR SCALING ROOF AND PILLARS, OIL-SHALE MINE

5 × 10-ft platform mounted on a Wagnormobile fork-lift truck. The truck is powered by a Diesel engine and has a power hoist for raising and lowering the platform from which the miners charge the explosive into the drill holes. In addition, there is a ladderway up the side of the hoist frame and a remote-control cable to permit lowering of the platform by miners working on it. The man-hours required for blasting have been reduced by about one third through use of the unit. At present, two miners can charge and blast a round in 5 hr. The rounds are loaded with three settings of the platform. All the holes of one series are wired at a time.

The labor required to charge explosive into horizontal holes has been reduced greatly, with no apparent loss in blasting efficiency, by eliminating tamping, except for the last cartridge loaded; this can be done by virtue of the constant-diameter borehole. At present, $1^{3}/_{4}$ × 8-in. cartridges of 45 per cent semigelatin explosive are used in 2-in. holes.

A scaling rig, Fig. 8, was acquired during the year; it consists of a wooden platform 3 ft deep and 14 ft long, mounted on a telescopic Wagnormobile fork-lift truck. With tower fully extended the platform of this truck is 65 ft above the ground, and it can be used on any level of the proposed mine structure. Two men working on the platform remove loose rock from the roof and the upper parts of pillars by means of aluminum rods with steel tips. A small percussion drill can be mounted on the platform for drilling loose slabs of rock not easily pried off.

A bulldozer with an overhead loader is used to push fly rock into the main pile of broken stone and to clean up broken rock not easily loaded by the shovel at the face.

COST AND ENGINEERING DATA

Progress made by the Bureau of Mines in developing methods, procedures, and equipment for mining oil shale on a large scale was publicly demonstrated before more than 500 representatives of industry during September and October, 1949. During this

demonstration the top level of the underground quarry was operated for two weeks and the bench level for the following two weeks. It was necessary to schedule the demonstration in this manner because enough equipment to operate both levels concurrently was not available.

The practices and equipment demonstrated are the most satisfactory so far developed. They offer an intermediate solution to the problem of low-cost oil-shale mining. Further research is expected to result in better methods.

Including the public demonstration run in September and October, three 4-week test runs have been conducted in the underground quarry. During each of these runs, operating procedures were identical with those which would be employed in one unit of a commercial mine. Experience gained in each of the runs was used to modify mining techniques and equipment for succeeding runs.

Throughout the first two test runs, oil shale was mined solely from the top level of the quarry.

During the first test run (August 9–September 3, 1948), all equipment required for mining the top level was available with the exception of the mobile utility station and a third truck. The heading jumbo, however, was equipped with 11-ft drill feeds instead of the 15-ft feeds mentioned previously and could drill a round that would break only about 10 ft.

An average of 840 tons of shale was broken each day of the first test run, and the average output for each man-shift of underground labor was 81 tons. The output per man-shift of total labor, including direct supervision, engineering, and all maintenance, was 56 tons. The direct cost of mining was 49.7 cents a ton, excluding depreciation and overhead.

In the period between the first and second test runs, the mobile utility station was designed and constructed; 15-ft drill feeds were designed and installed on the jumbo; a third truck was obtained for the ore-loading crew; and a thorough study was made of methods for increasing blasting efficiency and lowering the cost of drill bits and rods.

An average of 1492 tons of shale was broken each day of the second test run (April 11–May 6, 1949). A direct mining cost of 32.9 cents a ton and a production of 111 tons per man-shift for underground labor and 92.7 tons per man-shift for total labor, including direct supervision, engineering, and all maintenance, reflected improvements in all phases of the mining operation. The greatest improvement was the installation of 15-ft feeds on the drill jumbo.

TABLE 1 COSTS PER TON

	Labor[a]	Supplies	Power	Total
Drilling	$0.022	$0.021	$0.004	$0.047
Blasting	0.010	0.074	...	0.084
Loading	0.032	0.002	0.003	0.037
Transportation	0.047	0.004	...	0.051
Scaling	0.018	...	...	0.018
Direct supervision and engineering	0.013	...	...	0.013
Electrical distribution	...	0.016	...	0.016
Miscellaneous	0.001	0.004	0.002	0.007
Labor burden	0.019	...	...	0.019
Total	0.162	0.121	0.009	0.292

[a] Includes maintenance labor.

During the period following the second test run the work on the top level of the quarry was directed toward improving over-all techniques and adjusting the schedule to eliminate delays in the ore-loading and transportation cycle. A water-tank truck was obtained for transporting water and wetting rock piles on both levels of the mine, and a 22-ton truck was rented to replace one of the standard 15-ton trucks. In addition, a benching jumbo and a new scaling rig were designed and procured. Just prior to test run No. 3 the first rounds were blasted from the bench level of the mine, and the drilling and blasting procedures to be used during the run were determined. During this run 32,560 tons were mined and 148 tons per man-shift underground were produced. Total production per man-shift was 116 tons.

Cost data based on the results obtained in the third test run are presented in Table 1.

It will be noted that the costs listed are for work on the top and middle levels. The third level will be worked in a similar manner to the middle; direct costs are expected to be less and should bring down the over-all average.

The goal set up at the beginning of the project was 100 tons per man-shift per underground worker. The test run indicates that this can be bettered. Production of over 100 tons per man in an underground mine would be unique—at least as far as known, it has not been done except during the test run at Rifle.

Petroleum Research

WITH the completion this fall of a new radiochemical laboratory at the Bartlesville, Okla., Petroleum Experiment Station of the Bureau of Mines, U. S. Department of the Interior, technologists at the station will be able to use radioisotopes in attacking many problems connected with the production and refining of petroleum, according to Secretary of the Interior Oscar L. Chapman.

Since radioisotopes were made available by the Atomic Energy Commission, they have been used as tracers in many fields of research. Although Bureau scientists and technologists have recognized the desirability of applying isotope techniques to the solution of petroleum problems, they have been unable to do so in the past because of the lack of laboratory space and radiation-detecting equipment.

The laboratory is designed for the use of radioisotopes as tracers in various investigations in the secondary recovery of petroleum by water flooding and the injection of gas and air. The first application will be in using tracers, both radioactive and stable, in waters used for subsurface injection water-flooding. With the availability of tracers that can be introduced at input wells and detected at producing wells, data which have been unobtainable in the past will be provided. The use of such tracers is expected to show accurately, for instance, the exact extent and rate of advance of the water.

The laboratory, specially designed with the advice and approval of the Atomic Energy Commission, will include safeguards against the possibility of overexposure to radiation or contamination from spilled or dispersed radioactive matter. It is to be constructed largely of materials that can be decontaminated easily or replaced economically if necessary, and the ventilating equipment will provide more frequent changes of air than that used in conventional laboratories.

The building will include a small "hot" laboratory for storing and handling the radioisotopes as received, an adjoining intermediate laboratory where the isotopes will be diluted and separated, and a large laboratory for actual tracer work. There also will be a room where radioactivity can be detected and measured, and a dark room for developing "film badges" (used as an indication of the presence of ionizing radiation) and for preparing radioautographs.

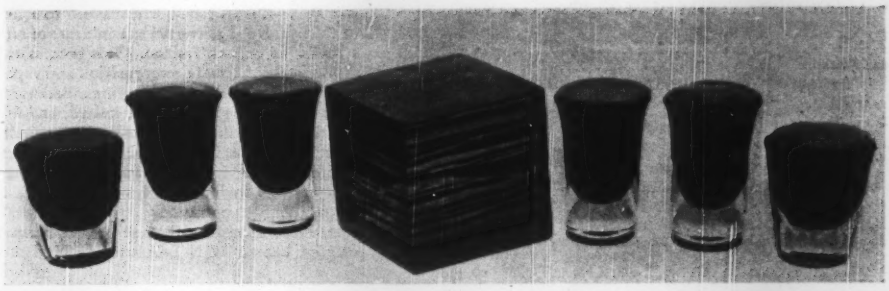

FIG. 1 OIL SHALE AND SHALE OIL

(From a 3-in. cube of oil shale, assaying 38 gal per ton by the modified Fischer assay method, 6 fluid ounces of shale oil can be obtained by the Bureau of Mines gas-flow process as described in this paper.)

EXTRACTION *and* REFINING* *of* SHALE OIL

By BOYD GUTHRIE[1] AND LESTER SCHRAMM[2]

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BEFORE the United States had emerged from the last world war, Congress became concerned over the fact that the demands for oil had increased tremendously while the nation's reserve capacity to produce oil had been diminishing. The possibility of an oil shortage loomed as a serious threat to national security. The petroleum industry was doing a magnificent job of providing our armed forces with all the petroleum products they needed; but it was a strain on our domestic production, and there was grave doubt as to whether our military strength would suffer for lack of oil should we become involved in some future war.

Under the leadership of Senator Joseph C. O'Mahoney of Wyoming and former representative Jennings Randolph of West Virginia, Congress enacted legislation which authorized the Bureau of Mines to establish demonstration plants, as well as pilot plants and research laboratories for developing the technology necessary to supplement petroleum products with liquid fuels produced from some of our more abundant fuel resources, especially oil shale and coal. Oil-shale research laboratories were established at Laramie, Wyo., and the Oil-Shale Demonstration Plant was set up near Rifle, Colo., to develop efficient techniques for mining oil shale and for extracting and refining shale oil. At the demonstration plant, a mine and a retorting plant, which produces crude shale oil, have been in operation since May, 1947; an experimental shale-oil refinery went on stream last July.

The purpose of this paper is to tell briefly the nature and characteristics of oil shale, to explain how oil is obtained from the rock, to describe the crude shale oil thus obtained, and to describe the method and equipment being used at Rifle to refine this oil.

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NATURE AND CHARACTERISTICS OF OIL SHALE

Oil shale is a sedimentary rock, Fig. 1, containing organic matter which, for the most part, is unaffected by solvents but is capable of yielding oil on heating. Colorado oil shales range from gray to dark brown (almost black), depending upon the proportion of organic material present. Although there is no outward appearance or feel of oiliness, thin pieces of rich shale can be ignited with a match and will burn with a sooty flame, producing an odor similar to that from burning petroleum.

During middle Eocene time, roughly, 60 million years ago, a broad, shallow body of water, now called Uinta Lake, covered northwestern Colorado and east-central Utah; a similar lake, known as Gosiute Lake, existed in southwestern Wyoming.[3] Each of these contemporary lakes was bounded by high hills, draining southward. During a period known as the Green River epoch, estimated to be between 5 and 8 million years, dust from the air as well as inorganic matter from the hillsides, which were carried to the lakes by the run-off water of rain and melting snow, were deposited on the bottoms of the lakes, forming what is now known as the oil shales of the Green River formation. Along with this sedimentation of mineral matter, the remains of primitive aquatic plants and animals that grew in the lakes were deposited and subsequently became altered (more or less bituminized), resulting in solid, amorphous, organic material called "kerogen," which is the source of the oil that can be extracted from oil shale.[4]

An analysis of a typical sample of oil shale of average grade from the Green River formation is shown in Table 1.

[3] "Oil-Shale Resources of Colorado, Utah, and Wyoming," by Carl Belser, *Petroleum Technology*, American Institute of Mining and Metallurgical Engineers Technical Publication 2358, May, 1948, 11 pp.

[4] For further information on the origin and geology of oil shale, see: "Origin and Microfossils of the Oil Shale of the Green River Formation of Colorado and Utah," by W. H. Bradley, U. S. Geological Survey Professional Paper 168, 1931; and "Oil Shale of the Rocky Mountain Region," by D. E. Winchester, U. S. Geological Survey Bulletin 729, 1923, 204 pp.

TABLE 1 ANALYSIS OF A TYPICAL GREEN RIVER OIL SHALE

Physical properties:	
Specific gravity, 60 deg/60 deg F	2.3
Bulk density, 48-mesh, lb/cu ft	67.8
Yields, based upon modified Fischer assay, weight per cent:[a]	
Oil	10.3
Gas	2.5
Water	1.4
Organic residue	3.1
Mineral residue	82.7
Total	100.0
Oil, gal/ton	26.7
Mineral CO_2	20.0
Mineral analysis of ash after evolution of CO_2, weight per cent of raw shale:	
SiO_2	26.4
CaO	17.1
MgO	5.4
Al_2O_3	6.6
Na_2O and K_2O	3.7
Fe_2O_3	2.6
P_2O_5 and V_2O_5	0.4
Sulphur as SO_3	0.5

[a] "Method of Assaying Oil Shale by a Modified Fischer Assay Retort," by K. E. Stanfield and I. C. Frost, Bureau of Mines Report of Investigations 3977 (1946), 11 pp., or 4477 (1949) which is a revision of R.I. 3977.

RETORTING[b]

The organic matter in oil shale decomposes at temperatures from 600 to 800 F. If the heating is continued to a little over 900 F, all of the kerogen is converted to a mixture of oil vapors, fixed gases, and solid organic residue. This process of heating oil shale to obtain the thermal decomposition and vaporization of its solid organic content is called retorting. Because there are many ways in which the shale may be heated, and many mechanical contrivances possible for handling the shale, many different retorts have been invented, and the patents that pertain to retorting number in the thousands. Condensation of the oil vapors produces crude shale oil, a viscous black material similar to petroleum in appearance.

The first retorts constructed at Rifle were two internally fired batch-type units known as N-T-U retorts, Figs. 2 and 3.

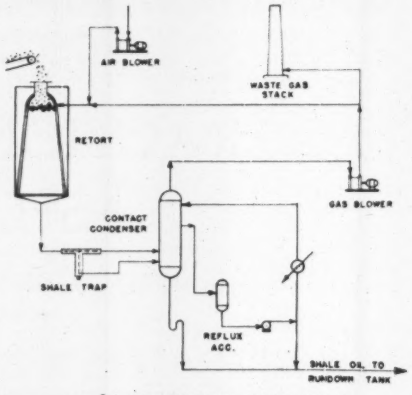

FIG. 3 N-T-U RETORT FLOW DIAGRAM

These are of demonstration-plant size, each holding about 40 tons of shale. Basically, an N-T-U retort is simply a brick-lined vessel with a manhole in the top for charging raw shale, and a hinged bottom which can be opened to discharge spent shale. A fire is lighted on top of the shale bed to start the process, and a centrifugal blower creates a draft from the top of the retort to the bottom. The combustion zone advances from top to bottom of the shale bed, and gases produced by the fire heat the raw shale below the burning bed, causing thermal decomposition and vaporization of the organic matter, yielding mainly oil, a considerable quantity of fixed hydrocarbon gases, and some solid, cokelike organic residue. As the fire zone continues slowly downward, it burns this organic residue, providing ample heat for the process. The vapors are cooled in a condensing system, and the oil is recovered.

In N-T-U operations considerable difficulty was experienced because of the presence of a shale-oil mist in the gas stream leaving the product-recovery system. The mist was deposited in the lines and equipment and formed a hard carbonaceous layer, making it necessary to dismantle and clean the various parts of the gas-circulating system. Mechanical alterations have practically eliminated the mist.

The N-T-U retorts are lined with firebrick, since the temperature of the fire bed is 1800 to 2200 F. In the lines and vessels of the condensing system, carbon steel is used throughout, with one exception, the water-cooled reflux oil cooler. Owing to the corrosive nature of cooling water used in the plant, the tubes failed, and tube bundles made of Admiralty metal were used to replace the original carbon-steel tubes. From this it would appear that in a commercial plant some treatment of Colorado River water to reduce corrosive tendencies probably will be required, even for cooling water.

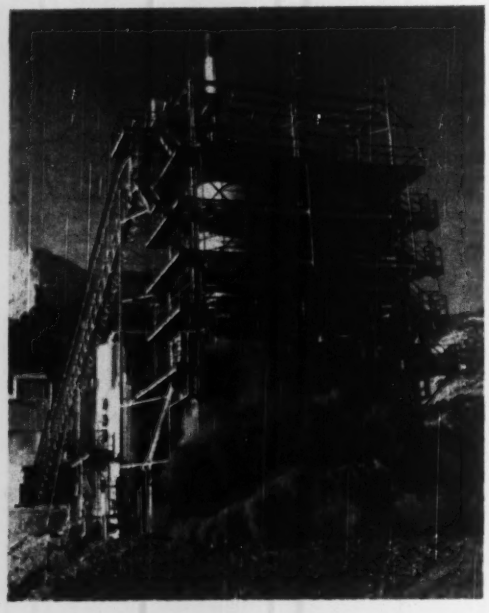

FIG. 2 SMOKE, FIRE, AND DUST BURST FORTH AT THE END OF EACH RUN WHEN 35 TONS OF SPENT SHALE ARE DISCHARGED FROM EITHER OF THE TWO N-T-U RETORTS

[b] More complete information on retorting is contained in Synthetic Liquid Fuels, 1948 Annual Report of the Secretary of the Interior, Part II—Oil From Shale, Bureau of Mines Report of Investigations 4457, 1949, 56 pp.; and Synthetic Liquid Fuels, 1949 Annual Report of the Secretary of the Interior, Part II—Oil From Shale, Bureau of Mines Report of Investigations 4652, February, 1950, 70 pp.

A continuous unit, known as the Bureau of Mines gas-flow retort, Figs. 4 and 5, has been built on a pilot-plant scale at the Oil-Shale Demonstration Plant and shows considerable promise of being a satisfactory process for commercial production. In principle this retort resembles the Grande Paroisse (also known as the Lantz) retort which is one of several types of retorts being operated in France. The gas-flow retort is a vertical vessel having a rectangular cross section. Two opposite sides of the unit are louvered to allow hot gas to pass horizontally through the shale bed, which flows continuously from the top to the bottom of the vessel. In the pilot plant at Rifle, a portion of the fixed gas formed during thermal decomposition of the kerogen in the retort is used as the heat-carrying vehicle, heat being transferred to the gas by means of pebble stoves fired with propane, the gas being circulated by a cycloidal-type blower. In a commercial plant, instead of burning propane, the heat would be supplied by burning the organic residue from the spent shale, together with part of the gases formed in the retort. The principle of this process differs from the N-T-U mainly in that combustion takes place outside the retort, whereas the N-T-U is an internal-combustion type. In the gas-flow retorting system, combustion gases are not mixed with "make" gas resulting from decomposition of kerogen.

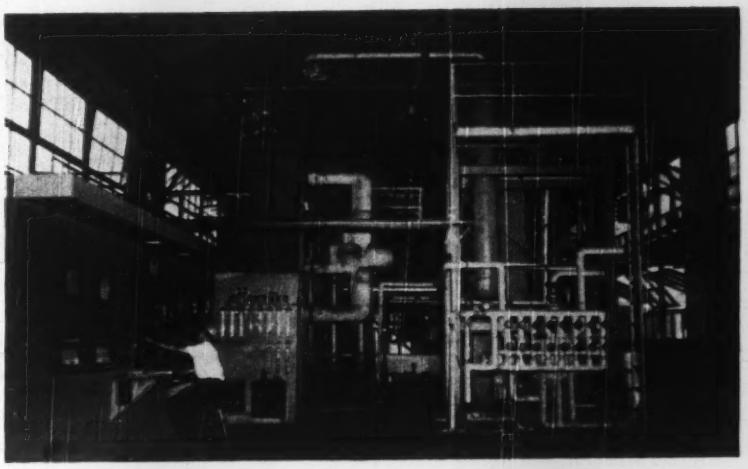

FIG. 4 A CONTINUOUS UNIT KNOWN AS THE BUREAU OF MINES GAS-FLOW RETORT HAS BEEN BUILT AND OPERATED ON A PILOT-PLANT SCALE

Heat-resistant materials were used for the hottest parts of the gas-flow system; the pebble stoves are lined with firebrick, the retort vessel is stainless steel, and the louvers are cast iron. The hot gases leave the stoves at temperatures ranging from 1500 to 2300 F but are quenched to around 1250 F before they enter the retort. Brick-lined piping is used from the stoves to a point a little beyond where the quench gas enters and from this point to the retort, stainless steel is used. Spent shale leaves the retort at 900 to 1000 F and is removed by a Syntron vibrator, followed by a water-jacketed drag-chain conveyer which discharges into a star feeder, the purpose of which is to emit the solid material from the system without significant loss of gas and oil vapors.

At least two other retorts have been developed which have possibilities of becoming important commercially. These were originated by oil companies, one by the Union Oil Company of California, and the other by the Standard Oil Development Company, a subsidiary of Standard Oil Company of New Jersey. Under co-operative agreements with these companies, the Bureau has been furnishing crushed shale for operating the companies' large pilot plants. The Union Oil Company retort is a continuous adaptation of the N-T-U, being a downdraft, internally fired retort, while Standard Oil Development Company process is based upon the continuous fluid catalytic-cracking process used in petroleum refining.

It is too early to say which of the continuous retorts will prove to be superior to the others or whether more than one will be used commercially. The principal advantages of the various processes are as follows: The gas-flow process produces

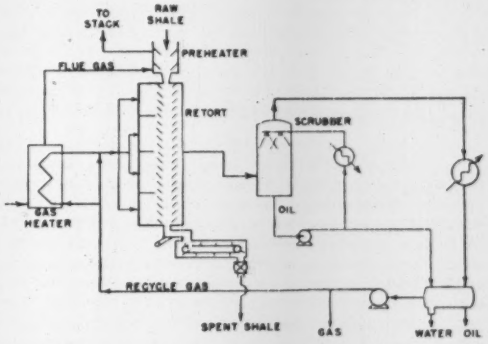

FIG. 5 PILOT-PLANT FLOW DIAGRAM OF GAS-FLOW PROCESS

fuel gas as a by-product and obtains a high yield of oil; the Union Oil Company retort produces low-quality gas as a by-product and uses cold raw shale to condense the oil vapors, requiring no condensing equipment and no cooling water; the Standard Oil Development Company process utilizes rapid solid-to-solid heat transfer, produces by-product fuel gas, and presumably will have a high shale throughput.

NATURE AND CHARACTERISTICS OF SHALE OIL

The liquid produced by retorting oil shale is a black waxy oil having a gravity of about 21 deg API and, due to its high wax content, a pour point of about 90 F. Crude shale oil is composed mainly of hydrocarbons, consisting of olefins paraffins, naphthenes, and aromatics, but appreciable amounts of sulphur, nitrogen, and oxygen compounds are present. While shale oil bears some resemblance in several of its physical and chemical properties to coal tar, and in others to petroleum, many of its characteristics are so unlike either coal tar or petroleum that it must be considered in a separate category.

From the standpoint of the petroleum refiner, the most important differences between shale oil and petroleum are that

TABLE 2 COMPARISON OF MID-CONTINENT PETROLEUM AND N-T-U SHALE OIL

	N-T-U shale oil	Oklahoma City crude petroleum
Crude:		
°API at 60 F	20.4	39.0
Sulphur, per cent	0.78	0.14
Nitrogen, per cent	1.97	...
Pour point, deg F	80	5
Viscosity, SUS at 100 F	200	45
Distillation summary, per cent:		
Naphtha	3.6	28.4
Light distillate	19.8	25.0
Heavy distillate	25.6	18.6
Residuum	49.8	26.3
Loss	1.2	1.7
Naphtha properties, per cent:		
Tar acids	3.0	...
Tar bases	9.0	...
Components:		
Paraffins } Naphthenes }	34	61 29
Olefins	50	...
Aromatics	16	10

shale oil contains high percentages of olefins, aromatics, and compounds of sulphur, nitrogen, and oxygen, but low percentages of paraffins and naphthenes as compared to petroleum. Although the sulphur, nitrogen, and oxygen compounds can be removed by treatment with acid and dilute caustic, they are of such types that their removal is rather difficult; furthermore, treating losses are high as compared with those accompanying the treatment of petroleum distillates because of the high percentage of unsaturated compounds in shale oil. As compared to most petroleums, shale oil, due to its unsaturation, is deficient in hydrogen. Some of the properties of shale oil as compared with a typical Mid-Continent crude are shown in Table 2.

REFINING

By relatively simple refining, using conventional petroleum-refining equipment, shale oil will yield a range of acceptable fuel oils. Without any refining whatever, crude shale oil from the N-T-U retorts has been used to fire the boilers at the Oil-Shale Demonstration Plant and was found to be very satisfactory. The manufacture of motor and Diesel fuels, with yields and qualities comparable to petroleum, is not so simple and will require a different approach from that of petroleum refining. Recognizing the problems involved in producing highly refined products from shale oil at reasonable cost and without excessive refining losses, the Bureau is carrying on an extensive research program, part of the work being done by its research laboratories at Laramie, Wyo., part at Rifle, Colo., and part by co-operating organizations, such as the oil companies.

It was decided that the initial demonstration refinery installation at Rifle should be a semicommercial plant of the smallest size that could be built using conventional petroleum-refining equipment, particularly a conventional heater. Operation of such a plant not only would provide various liquid fuels in quantities sufficient for service tests but also would reveal the processing characteristics of shale oil and would furnish cost data. After thorough study, it was decided that an adaptation of the single-coil Dubbs thermal cracking process and a cold-acid treating unit would be most satisfactory for the initial installation. Accordingly, a small, semicommercial refinery having a rated capacity of 300 bbl per stream-day through the heater, has been erected at the Oil-Shale Demonstration Plant and has been in operation for a short time, Figs. 6, 7, and 8.

This refinery consists of the following:

1 A single-coil cracking furnace designed to operate under all conditions of atmospheric distillation, thermal cracking, and reforming.

2 Two coke chambers, one of which will also serve as a reaction chamber during recycle-cracking operations.

3 A flash fractionator which will separate the oil into gasoline, light gas oil, heavy gas oil, and heavy fuel oil.

4 A side-cut stripper for removing light components from the Diesel fraction.

5 An absorber to recover the liquefiable portions of the gases produced in cracking.

6 A stabilizer to remove excessive quantities of butane and any lighter hydrocarbons from the naphtha, yielding a gasoline fraction of the desired vapor pressure.

7 A continuous low-temperature acid-treating unit to provide for treating of motor-fuel fractions for nitrogen, sulphur, color, and gum control.

8 A rerun distillation unit for removing high-sulphur polymers from the gasoline after the acid treatment.

9 A continuous doctor sweetening unit to convert objectionable odorous components of the gasoline or other distillate fractions to sweet compounds.

In designing the thermal-processing part of the plant, flexibility of operation was one of the prime considerations. With the same equipment, any of the following conventional thermal refining operations can be carried out: Atmospheric distillation; coking; viscosity breaking; single-coil recycle cracking; reforming.

All these operations except reforming have been performed and the products made are gasoline, Diesel fuel, distillate burner fuels, residual fuels, coke, and fuel gas. Although simple

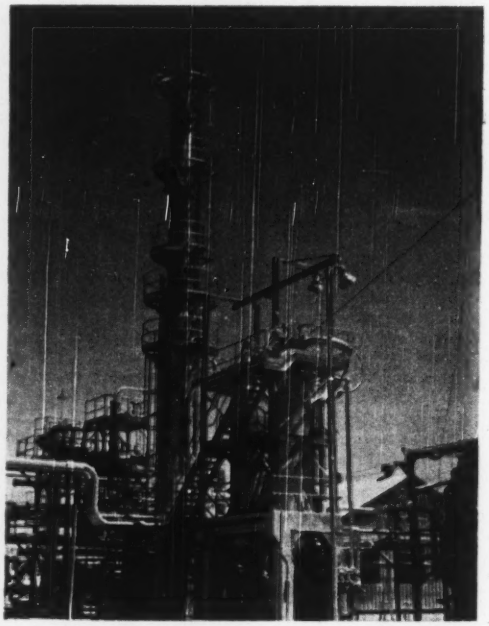

FIG. 6 THERMAL PROCESSING UNIT OF SHALE-OIL REFINERY

(From right to left are shown the heater, only partly visible, two coking chambers, the nearer one of which may also be used as a reaction chamber, and flash fractionator. The smaller columns partly hidden by the maze of piping are a side-cut stripper, an absorber, a stabilizer, and a gasoline rerun column.)

topping yields only about 5 per cent gasoline, 40 to 50 per cent gasoline has been obtained by coking and recycle cracking. The motor octane numbers of the raw cracked gasolines ranged from 62 to 69; after treating and leading (3 cc tetraethyl lead per gallon), the octane numbers were all close to 73 motor method and 80 research. Finished shale-oil Diesel fuel, produced by viscosity-breaking operations, had a cetane number of 47 after treating, and in service tests it has performed satisfactorily in 15-ton Euclid dump trucks and other Diesel-powered mining equipment. Preliminary laboratory tests showed that the light gas oil meets the requirements for a No. 3 fuel oil. The heavy gas oil is a satisfactory stock for thermal

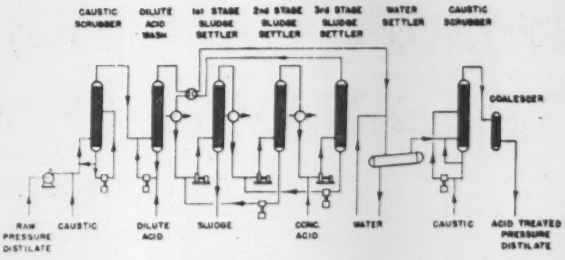

FIG. 8 COLD-ACID TREATING UNIT

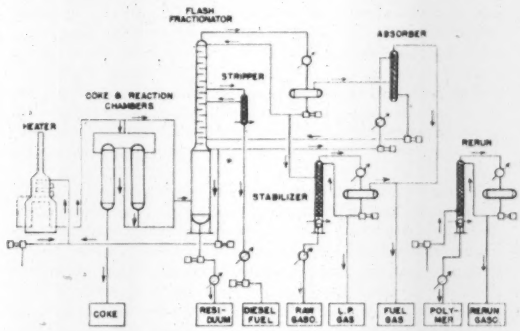

FIG. 7 COKING—CRACKING UNIT

cracking and the residuum can be made to meet specifications for either a No. 5 or a No. 6 fuel oil.

In the refinery, recycle cracking demands the most severe operating conditions encountered in any of the operations to be performed in the thermal-processing unit; therefore the mechanical design specifications of the unit were based on the mechanical requirements of that operation.[6] In designing the refinery, materials were selected primarily on the basis of strength required, except in that portion of the treating plant which handles dilute acid, where corrosion was the main consideration. In the thermal unit, it is believed that corrosion will not be severe because the sulphur compounds are of a less reactive type than those found in petroleum, and because the nitrogen compounds have a corrosion-inhibiting effect. Consequently, minimum corrosion protection has been provided in the thermal unit.

The tubes and headers in the heater are rated for 1000 psi at 1050 F. The reaction chamber (which will also be used as a coking chamber) can be operated at 330 psi and 950 F. The other chamber is designed for pressures up to only 125 psi and is suitable for the coking operation only. In the transfer line and heater crossover connections, alloy steel containing 4 to 6 per cent chromium and $^1/_2$ per cent molybdenum was used to give the desired tensile strength, with some corrosion resistance. The tubes in the heater are low-alloy steel containing 2 per cent chromium and $^1/_2$ per cent molybdenum, with steel fittings containing $2^1/_4$ per cent chromium and 1 per cent molybdenum. Pumps, exchangers, and control valves were all specified in accordance with the usual practice for high-sulphur crudes. None of the vessels is lined, but provision has been made for possible addition of a ganister lining in the coke drums and flash chamber at a later date.

In the chemical-treating plant, carbon steel is used throughout, with the exception of equipment handling dilute acid and ammonia. The dilute-acid and water settlers are lead-lined and are served by Hastelloy B jet mixers and stainless-steel pipe, Nos. 20 and 304. The ammonia-refrigeration piping system consists of carbon steel with cast-iron fittings.

COMMERCIAL POSSIBILITIES

In some of the European countries people have been extracting oil from shale for a century or more. At present there are fair-sized shale-oil industries in Sweden, France, and Scotland, and production on a more limited scale in several other countries. In the Green River formation of Colorado, Utah, and Wyoming, we have larger and richer deposits of oil shale than most of those in foreign countries. Why, then, has a shale-oil industry never been established in the United States? The answer is purely a matter of economics. The United States has been fortunate in being able to produce enough petroleum to meet the demands of the country, and the price has been considerably lower than the selling price of shale oil could possibly have been except for a period during the 1920's. At that time, several attempts were made to produce shale oil commercially, but due to fabulous petroleum discoveries, followed in 1930 by discovery of the East Texas oil field, the price of petroleum declined again, and all attempts to produce shale oil commercially were abandoned.

However, the situation is changing. Due to the increased difficulty of finding new petroleum, the price of crude has risen sharply during the last few years. This, together with advances being made in the technology of mining and processing oil shale and of refining shale oil, is bringing the cost of liquid fuels from petroleum and liquid fuels from oil shale close to the same level. If present trends continue, it will not be long until shale oil can supplement petroleum at a comparable price.

It is estimated that the cost of producing crude shale oil from 30-gallon per ton shale using the mining technique developed and demonstrated at Rifle and retorting by the gas-flow process, would be about $1.50 a barrel.[7] This includes estimated out-of-pocket operating costs and depreciation, but not income taxes or profit. In establishing a depreciation rate, the life of each individual piece of mining equipment was estimated, resulting in an average life of about 7.5 years. Depreciation of plant equipment over a 15-year period was assumed.

To calculate a selling price, it would be necessary to allow

(*Continued on page 732*)

[6] "Experimental Shale-Oil Refinery," by H. Boyd Morris and D. L. Gilbertson, *Petroleum Engineer*, vol. 21, August, 1949, pp. C-26–C-32.

[7] Synthetic Liquid Fuels, 1949 Annual Report of the Secretary of the Interior, Part II—Oil From Oil Shale: Bureau of Mines Report of Investigations 4652, February, 1950, 70 pp.

Prospects of GAS TURBINES *in* NAVAL APPLICATIONS

By R. T. SIMPSON[1] AND W. T. SAWYER[2]

HISTORICAL

HERO, the Alexandrian, is credited with first conceiving the principle of the gas turbine in 130 B.C. The first patent was issued to the Englishman, John Barber, in 1791. Despite these very early origins, real progress was not realized until made possible by advances in the metallurgical and aerodynamic sciences early in the twentieth century. By 1930, however, very positive progress was on record, including the turbosupercharger developed in this country by Dr. Sanford Moss. That year marked the appearance on the drafting boards of Whittle's first aircraft gas-turbojet engine and ushered in the really modern era of extremely rapid development. A full chronology of gas-turbine development during the long period so briefly referred to may be found in the work of R. T. Sawyer (1),[3] Moss (2), and others (3, 4, 5, 6).

During the 1930's important advances were made by the Swiss firms of Brown-Boveri, Escher Wyss, and Sulzer in their programs of locomotive and land power station gas-turbine development. These events were reported comprehensively to the Navy Department's Bureau of Engineering by Lieutenant Commander Warren Noble, U.S.N.R., in 1938. His estimate of the situation was so startlingly enthusiastic that the Department almost immediately requested an investigation by a committee of the National Academy of Sciences into the feasibility of harnessing this "new" work horse for naval propulsion. This committee, after almost two years of study, recommended the establishment of a naval gas-turbine program, including the construction and exhaustive laboratory testing of a gas turbine capable of sustained operation at 1500 F (3). With the adoption of this recommendation and the appointment of Dr. R. B. Kleinschmidt as the technical director of the program, the Navy embarked upon a long voyage during which we have seen lots of rough weather. However, in spite of metallurgical hurricanes, aerodynamic typhoons, and mechanical siroccos, subsequent events have established the wisdom of this basic undertaking.

To initiate the original program, a contract was negotiated in December, 1940, with the Allis-Chalmers Company for the design and construction of a 3500-hp unit suitable, not for installation in a ship, but for the laboratory investigation of those components which most logically might be used in a prototype shipboard plant (7).

This step was followed, a year later, by the setting up of a program of high-temperature-materials research at both the U. S. Naval Engineering Experiment Station (8) and the Massachusetts Institute of Technology (9).

Twelve months later, in 1942, two other laboratory models were placed on order. One of these, the Elliott 2500-hp unit utilizing Lysholm compressors, has been reported upon by several of the participating designers (10). The other, a 750-hp unit to be manufactured by the DeLaval Company (11), was to utilize a Birmann mixed-flow compressor, thereby providing a logical complement to the axial-flow and Lysholm machines already on order.

The year 1943 saw the Bureau of Ships extend its program to include two free-piston gas-generator projects (12), and a study of pressure-fired boilers, thereby completing the setup of a six-pronged assault on this propulsion gas-turbine problem.

Those six projects have formed a framework or foundation structure for the work which has followed. An outgrowth of the original Elliott 2500-hp laboratory plant has been the authorization for the construction of a similar 3000-hp propulsion plant (13) intended for installation in a vessel. Literally hundreds of interlocking and dovetailing projects have been undertaken, ranging all the way from paper studies, accomplished by one engineer in a week, to the design, construction, and test of hardware involving a great many technicians for a great many months.

OUTLINE OF PRESENT BUSHIPS ACTIVITIES

Cycle Studies. The wealth of literature available on the subject of the selection of the optimum cycle for a given application attests the magnitude of the task of arriving at any one answer which, regardless of how intelligent it may appear at the time of design conception, will continue to appear intelligent throughout the three to five years which is normally required to bring that conception through the successive stages of detail design, component construction and testing, component alteration, and final plant assembly and testing.

Our work is further complicated by the several special requirements of a naval plant with which the designers of merchant marine, aeronautical, locomotive, or stationary gas turbines do not particularly have to worry. These special requirements are as follows:

(*a*) Excellent cruising, or light load, fuel economy plus good fuel economy at the higher loads as well.

(*b*) Maneuverability—that is, ability to accommodate rapid changes from low power (or dead-plant conditions) to high power to stop to back and again to high power ahead, etc., in any sequence and with great frequency.

(*c*) Air economy—the requirements for air must be reduced to the minimum in order that the size and the weight of intake and exhaust ducting do not become prohibitive.

(*d*) Resistance to severe shock or other battle damage.

(*e*) Economy of strategic materials—it would be foolishly shortsighted to develop, at great expense in time and money, prototype machinery which could not in wartime be reproduced in the required quantities because of the unavailability of metals or materials essential to its satisfactory performance.

All of these special requirements are combined in a naval plant with the several nonspecial requirements which are com-

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[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

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NOTE: The opinions contained in this paper are the private ones of the authors and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service.

mon to one or more of the other applications, such as the following:

(*a*) Reliability—certainly this requirement is common to all applications, but it is particularly important to aeronautical, merchant-marine, and naval plants.

(*b*) Minimum weight—this requirement is almost paramount for aircraft applications but it is only a little less important in naval installations because every pound that is spent on main engines means one pound less that is available for vital ammunition, guns, armor, or fuel oil. It is also important in lessening degrees to locomotive and merchant-marine plants.

(*c*) Minimum space—aeronautical, naval, and locomotive applications have this requirement in common although "frontal area" is probably the prime factor for aircraft engines whereas all dimensions are important to locomotives and naval craft.

(*d*) Accessibility or ease of maintenance—this requirement, which is seemingly incompatible with the weight and space limitations mentioned, is probably more important in naval installations than in any other because of the necessity of operating for weeks and months away from shore-based repair facilities. However, it is an important consideration in all prime-mover designs regardless of application.

To utilize fully the versatility of the gas turbine in meeting the maximum number of the foregoing general and special requirements, we have devoted much time and man power to the study of those variables which have a profound effect upon the character and performance of the resultant plant. Proper cycle selection is the framework upon which the elements of aerodynamics, metallurgy, and other engineering sciences are added to achieve the desired result. Studies have been made, and are constantly being revised, on all the various cycles, mechanical arrangements, and different types of components known to us. Here again, it must be pointed out that the scope of these studies has varied from a few engineer man-days to many hundred man-days, including in some cases laboratory substantiation of predicted results.

Component Studies. A re-examination of the initial program described at the beginning of this paper will recall to mind that many different types of components were included in the six original projects. Those original projects therefore afforded opportunity for the thorough exploration of the performance characteristics and construction techniques involved with axial-flow, Lysholm, Birmann, free-piston, and controlled-piston compressors, and axial-flow reaction, axial-flow impulse-reaction, and Birmann mixed-flow turbines. The information generated by these investigations has been supplemented continuously by concurrent, or subsequent, studies of centrifugal, mixed-flow, and radial-inflow compressors, and of axial, radial-inflow, and radial-outflow types of turbines.

In addition to investigations of the many types of compressors and turbines indicated, the heading "Component Studies" must also include investigations such as that on extended-surface regenerators, various types of dynamic or "strong-wave" machines, the acoustic combustion chamber, various control devices, and control instrumentation.

Materials Studies. The materials investigation programs at Annapolis and M.I.T. mentioned early in this paper have concentrated primarily upon the development and application of suitable high-temperature blade material and, as in all other phases of the over-all program, our efforts have been co-ordinated carefully with those of the dozens of other investigators working on the same problem. Those two projects have been concerned primarily with the conventional superalloys of the chrome-nickel-cobalt type, but very considerable additional amounts of Bureau time and contract money have been spent on ceramics, powder metallurgy, casting techniques (including grain-size control), welding techniques, and material-inspection methods.

Turbine-Cooling Studies. Periodic analysis of the work on cycle selection, component development, and materials research has led us to place increasingly great emphasis (in terms of percentage of available man power and money) upon the development of suitable methods of cooling hot turbine parts in order to make higher top-cycle temperatures usable and/or to reduce the strategic material content required for satisfactory turbine life. The extremely encouraging results achieved in this respect at NACA as reported by Schey (14) and Ellerbrock (15), and the predictions of Hawthorne (16) have given us a good deal of faith in our own calculations. It would be hard to overstate the confidence which the authors have in the premise that some form of liquid cooling will be utilized on all naval and marine gas turbines in use ten years from the present. It appears that the future of air cooling for the hot turbine parts may not be spectacularly bright, but we believe that the field of liquid cooling offers a greater opportunity for clear-cut performance gains than any other one single line of exploration. Liquid cooling will probably be advantageous for all types of turbines regardless of application.

Other Present Bureau Activities. Security considerations prevent the further discussion of present Bureau activities along gas-turbine lines. It can be stated, however, as an index to this activity, that several top-flight gas-turbine manufacturers are presently engaged on construction contracts for the Bureau. These projects will be described publicly as soon as circumstances will permit.

PROSPECTS FOR THE FUTURE

What this country needs is not more rosy predictions of a bright future for the gas turbine, but more down-to-earth certified performance records. This "Glamor Girl," this "Pin-Up of the Power Profession," as the gas turbine was so aptly described by Lester Goldsmith four years ago, has been all but murdered in her golden teens by exaggerated publicity, extravagant predictions, and overzealous enthusiasm. The rude shock incident to a realistic inventory-taking process has soured many individuals on the whole subject and has caused many capable open-minded engineers to develop a "show-me" type of sales resistance to any favorable statement made concerning the gas turbine.

This feeling is particularly difficult to combat in the field of locomotive, marine, and naval propulsion. It cannot be said, as it can of the aeronautical gas turbine, that a marine, locomotive, or naval gas turbine is a vital necessity. The existing machinery available for those three applications is far from being unsuitable, outmoded, or insufficient for the task assigned. In those fields, the gas turbine must show a positively advantageous balance against its competition in order to receive the high-level favor necessary for the release of the very considerable investment funds involved in the development of even a moderate size of gas-turbine installation. The task is made more difficult also by the fact that the short 500-hr life which is suitable for aeronautical uses has not heretofore been acceptable in the other applications regardless of how many other attractive features the arrangement may possess.

Nevertheless the authors of this paper still believe that a strong case can be made for the gas turbine in naval applications if sound judgment and foresight are compounded with skill, energy, and perseverance in the administration of each project.

A characteristic of a propulsion power plant for naval combatant service which is unique in the general marine picture is the very widely varying power requirement. If we consider, for example, a destroyer of recent years, statistical studies during both peace and wartime have shown that such a vessel

operates for an overwhelming proportion of its total operating life at a very low proportion of the installed power.

Fig. 1 shows the statistical average operating history of a large number of vessels over an extended period of wartime operation. Fig. 2, which is an integration of the curves in Fig. 1, indicates that the upper 80 per cent of the installed horsepower is used for less than 4 per cent of the operating life of the vessel; 70 per cent for less than 1 per cent; and 60 per cent for less than 0.3 per cent.

A representative figure for those machinery weights which are uniquely associated with the steam-propulsion plant of the vessels studied is 16 lb per hp, including propulsion turbines, condensers and air ejectors, boilers, steam piping, blowers, feed-service pumps, tanks, heaters, heater-drain pumps, and circulating pumps. For a 60,000-hp twin-screw vessel (two identical 30,000-hp units), this means that for 99 per cent of the operating life of the vessel (during which 97 per cent of the total fuel is burned), 300 tons of propulsion machinery are carried about as a reserve against the sudden requirement for more than 30 per cent power. The practicability of replacing this top 70 per cent of installed power, which is required to operate for only 1 per cent of the life of the vessel, with a relatively short-life gas-turbine plant weighing between $^1/_2$ and 2 lb per shp is attractive and appears feasible within the presently existing state of the art.

One of the several potential arrangements for accomplishing this desirable result is, we believe, especially worthy of description. This arrangement was first proposed, as far as we know, by S. A. Kane, then of the Bureau of Ships, in 1946.

The Steam Cruising-Gas Booster Propulsion Plant. Considering a 30,000-hp propulsion unit, this arrangement would involve 9000 shp of steam machinery and 21,000 shp of lightweight compact gas-turbine machinery. We would be able to design

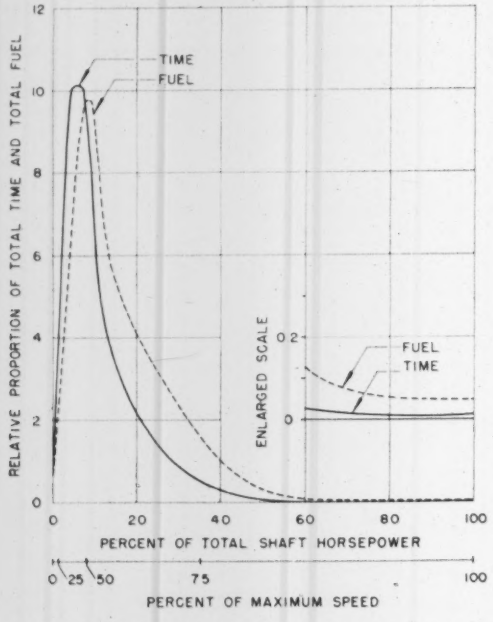

FIG. 1 RELATIVE STEAMING TIME AND FUEL CONSUMPTION OF AN AVERAGE DESTROYER AS A FUNCTION OF POWER REQUIREMENTS

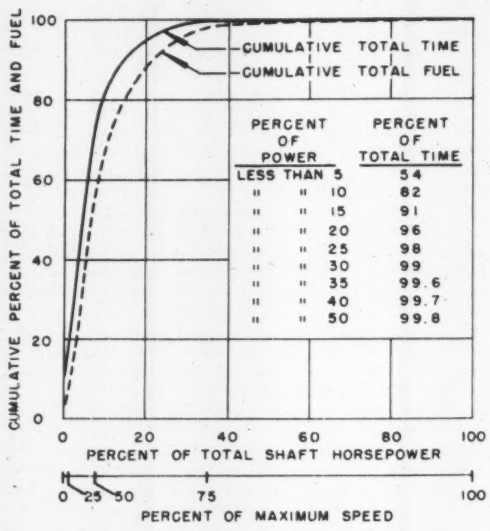
CUMULATIVE PERCENT OF TOTAL TIME AND FUEL
CUMULATIVE TOTAL TIME
CUMULATIVE TOTAL FUEL
PERCENT OF POWER
PERCENT OF TOTAL TIME
LESS THAN 5 54
" " 10 82
" " 15 91
" " 20 96
" " 25 98
" " 30 99
" " 35 99.6
" " 40 99.7
" " 50 99.8
PERCENT OF TOTAL SHAFT HORSEPOWER
PERCENT OF MAXIMUM SPEED

FIG. 2 CUMULATIVE PER CENT OF TOTAL STEAMING TIME AND TOTAL FUEL CONSUMPTION OF AN AVERAGE DESTROYER AS A FUNCTION OF POWER REQUIREMENTS

the steam plant especially for economical operation at the speeds for which it alone would be employed. Studies indicate that we should be able to utilize reduction gears of over-all size similar to those presently installed and to have both the steam-turbine and the gas-turbine torque delivered to this gear. If we conceive of the gas-turbine power being delivered by four to eight separate gas-turbine engines, we should then be able to separate these engines from the gear train by clutches when not in use.

The backing requirements, which for the ship under consideration would be of the order of 8000 shp (4000 hp per shaft) might be provided by astern wheels built into the steam-turbine casings in the conventional manner.

Fig. 3 shows a possible arrangement of this sort. Calculations indicate that such a plant may be built, within the framework of our existing knowledge, which would be competitive from a fuel-economy standpoint at all loads and still produce a net saving of about 260 tons (representing a 28 per cent reduction) in ship's propulsion equipment, even if a conservative figure of 2 lb per hp is used for the gas-turbine elements. The length of the over-all machinery space would be reduced, relative to the former steam plant, by more than 10 ft.

The steam component included in this arrangement would consist of a cross-compound turbine with a single-flow low-pressure element having the astern wheels in its exhaust casing. This turbine could be designed to give the maximum possible economy at the 20-knot point without undue sacrifice either at 9000 shp per shaft (which is the maximum power at which it would operate without gas turbines), or at 30,000 shp per shaft when operating in combination with the gas turbines.

Only one boiler per shaft would need to be provided since, in the event of a boiler derangement, the two steam plants could be cross-connected or the gas turbines operated alone if at least one of the five units per shaft were provided with a starting motor. Overheating of the steam turbine during

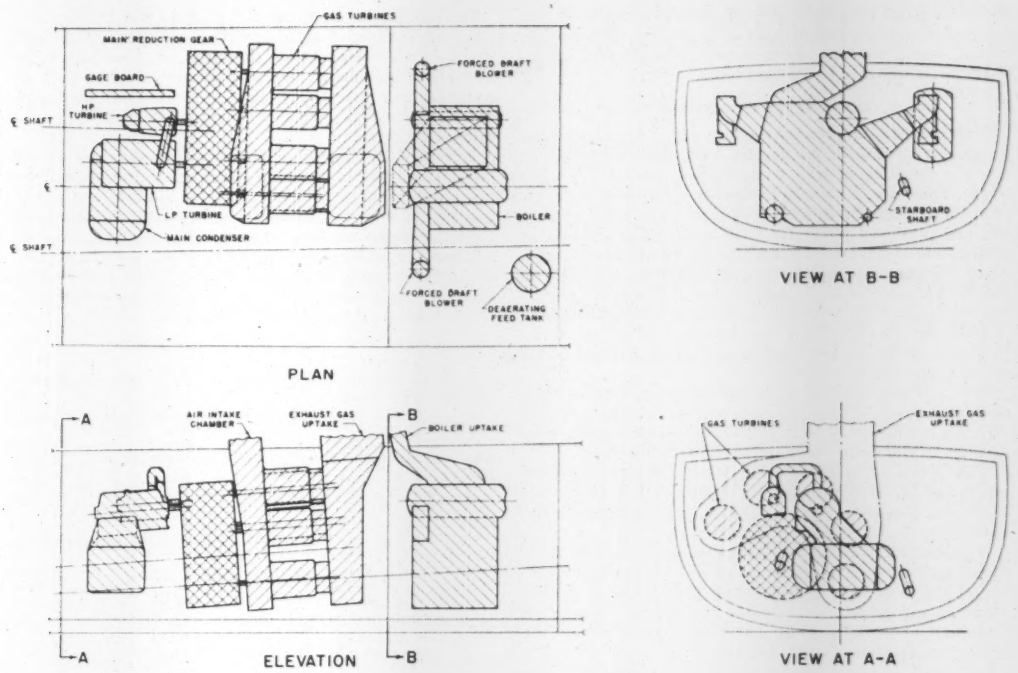

FIG. 3 DIAGRAMMATIC SKETCH OF PROPOSED STEAM TURBINE CRUISING-GAS TURBINE BOOSTER PROPULSION PLANT FOR ONE PROPELLER SHAFT OF A NAVAL VESSEL

operation with the gas turbines alone could be avoided by maintaining a vacuum in the condenser.

The boilers, turbines, condensers, and auxiliaries are visualized as being conventional, nonexperimental in nature, having normal design factors.

The reduction gears likewise would follow conventional design practice, except as to arrangement. Each gear would have five single-helical first-reduction pinions and gears, and five double-helical second-reduction pinions spaced at 45 deg around the 130-in. bull gear. Two of the high-speed pinions would transmit power from a gas turbine as well as one element of the steam turbine. The other three pinions would transmit power only from gas turbines. A friction clutch of the Fawick-Airflex type could be incorporated in each first reduction gear in the gas-turbine power train.

The five gas-turbine elements on each shaft would be interchangeable. They would be adaptations of the now familiar 500-hr open-cycle 2-shaft aircraft turbopropeller engine. Compressors would probably be axial flow and have a 10-to-1 pressure ratio. Combustion is accomplished in the familiar can-type chambers clustered about the central axis. The turbine-inlet temperature would be 1900 F, giving a design fuel rate of 0.6 lb per hp-hr at full power. The gas turbines should burn the same fuel oil as that used in the steam boiler.

The fuel economy of this combination steam and gas arrangement would be at least equal to that of comparable steam machinery at all speeds, and at the most important points, that is, between 20 and 25 knots, it would be from 10 to 13 per cent better.

The question may arise as to why, in a gas-turbine discussion, we have chosen for the base load or maneuvering plant a steam turbine rather than some configuration of gas turbines. Rather than that a lack of faith in the abilities of the gas turbine be inferred, it will here be noted that certain practical considerations have indicated the choice of the steam base-load plant. Sufficient emphasis must be given to fuel economy for the base-load or maneuvering plant (which will consume 97 per cent of the total fuel burned) to require that the base-load gas-turbine plant, if one be installed, attain efficiencies at all speeds comparable to the steam plant.

At the present state of the development, this can be achieved only at the expense of increasing plant weight and volume by the addition of intercoolers and regenerators. The gas-turbine plant then weighs nearly as much as the steam plant. In addition, meeting the reversing requirements involves the use of either a controllable and reversible-pitch propeller or a reversing transmission between turbines and high-speed reduction-gear pinions. Either alternative will arouse a very vocal group of antagonists.

While we favor the development of the base-load gas-turbine plant as a definitely worth-while project which certainly will receive future attention, economy may dictate that its further development be postponed for the moment. There are, furthermore, certain advantages, primarily of a philosophical nature, which accrue from the retention of the steam plant: (*a*) It is thoroughly developed, proved and tested, and operating personnel are familiar with its use. (*b*) It permits retention of certain steam auxiliary machinery primarily in connection with the ship's "hotel" load. (*c*) Its life is long and its reliability, which is a prime requisite, is excellent. Al-

though it may be a source of amazement to most of us, the question is asked occasionally, in all sincerity—"Will the gas turbine work?"—and to these skeptics, the presence of the steam machinery may be a reassurance.

OTHER NAVAL APPLICATIONS

There are many other naval applications, of a special nature, to which the versatile gas turbine lends itself admirably by virtue of some one or more of its uniquely advantageous features. There are, for example, applications, such as motive power for emergency equipment with a very short operating life, and peak-load power for boats and vehicles, where the requirement of lightweight subordinates all others save reliability. Applications exist where fuels with the volatility of gasoline are not acceptable, and where at the same time powers are sufficiently high or weight limitations sufficiently low to preclude the Diesel. Other requirements exist for machinery of moderate weight but high power which are capable of almost instantaneous starting.

For all of the foregoing, some form of gas turbine will precisely fill the bill. For example, currently under development for the Bureau of Ships is a 400-hp gas turbine for emergency generator drive with a weight of 600 lb and designed life of 5000 hr (including 500 hr at full power). This prime mover supplants a Diesel engine weighing 8900 lb, thereby saving 8300 lb (93 per cent of original weight) at no sacrifice, since fuel economy in this application is unimportant.

A gas-turbine prime mover for a portable fire pump shows promise of achieving a specific weight of 1.2 lb per hp for a 50-hp output, as compared with 3.7 lb per hp for its gasoline piston-engine predecessor. It has the added advantage of burning a nonvolatile nonexplosive fuel, which is for fire-fighting equipment definitely desirable.

LONG-RANGE DEVELOPMENT PROGRAM

In looking into the less immediate future with an attempt to predict the direction in which further development should take place, consideration should be given to all of the naval-plant requirements described in the foregoing. It appears certain, therefore, that very great effort must be exerted toward the attainment of satisfactory performance of units operating at the very high temperatures above 2500 F. To us this means concentration upon the liquid-cooling principle with the personnel and money necessary to achieve the same high degree of development which has been attained by the automotive and aeronautical piston-engine fields. These efforts must be expedited because successful attack upon the problems will depend to a very great degree upon laboratory experimentation with working models, a process which is extremely time-consuming to say the least.

Likewise, in order to make most advantageous use of these high temperatures, after successful methods of handling them have been developed, the satisfactory and efficient production of much higher pressure ratios than those now in general use will be required. Therefore this calls for continued concentration upon the development of compact, lightweight, highly efficient compressors, and probably the more effective utilization of intercoolers or wet compression. As an interim future step, we recognize the potential merit of an all-gas-turbine propulsion plant of 30,000 hp comparable to the combined steam and gas plant described, wherein the cruising element is composed of a piston gas generator—gas-turbine arrangement and the booster or high-power plant is composed of straight-through units with 25:1 pressure ratio (achieved by suitable intercooling or water-injection methods), operating at an initial turbine temperature of 2500 F or higher through the use of suitable liquid cooling of the hot turbine parts.

The problem of compressor fouling may well increase to such a degree as to make it desirable to give much greater emphasis to the development of the completely closed cycle than that which now exists. Reports being received from abroad on this subject indicate that our best efforts along the lines of development of the open-cycle units may be nullified by this matter of compressor fouling.

It seems wise, therefore, in planning a long-range program, to maintain a degree of flexibility which will permit the ultimate utilization of the closed cycle, both for realization of its own inherent advantages and for the contingency that the open-cycle-compressor fouling problem achieves dominating proportions. The closed cycle is so dependent upon the efficiency of its heat transfer elements that the program for the future must include continued study directed toward the improvement of their performance and reduction of their size.

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FUNDAMENTALS *of* ADHESION

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INTRODUCTION

THE most significant factor in adhesion is the molecular attraction operative between the adherend and the adhesive. There are many physical factors which affect the strength of a bond by determining the closeness of contact of the adherend and adhesive, by altering the surface area involved, or by influencing the stress conditions in the joint either as initially formed or under external loading. Although some of the strength of a bond between an adhesive and a porous surface can be attributed to tendrils of adhesive which enter the pores, this mechanical interpenetration cannot account for more than a small fraction of the joint strength. Evidence has accumulated from many pertinent fields which indicates that molecular attractive forces are primarily responsible for the bond between any two surfaces.

The types of chemical bonds involved in specific adhesion will be reviewed in this paper, followed by a discussion of various physical factors which affect bond strengths.

CHEMICAL FACTORS IN ADHESION

In considering the chemical and physical phenomena involved in adhesion and cohesion, four general types of chemical bonds must be recognized; electrostatic, covalent, and metallic, which are referred to as primary valence bonds, and residual bonding attraction forces, commonly known as van der Waals' forces, which are referred to as secondary valence bonds.

PRIMARY BONDS

Electrostatic Bonds. Electrostatic or polar bonds are the type which act to hold together the atoms in common salts. An element immediately preceding a rare gas in the periodic table is strongly electronegative, whereas one immediately following it is strongly electropositive. There is a tendency on the part of the reactive elements to change their configurations to conform with those of the rare gases, which are remarkably inert. Thus an atom of potassium combines with one of chlorine by means of an electron transfer which results in the configuration of argon for each, Fig. 1.

By means of this mutual claim on the transferred electron the two ions will remain closely associated with one another as potassium chloride. This association can be interfered with, however, as by solution in water, in which case the potassium chloride will dissociate into chlorine as a negative ion and potassium as a positive ion. If the water is removed by evaporation, these ions will align themselves to form a crystal lattice. In such a solid the attractive forces between the oppositely charged ions, except those on the surface, will be satisfied. However, in an amorphous solid some of the attractive polar forces will not be satisfied because of randomness of distribution of the ions.

Covalent Bonds. These are the type which act to hold together the atoms of carbon, hydrogen, and other elements in organic compounds. It is also this type of bond which holds the atoms together in diatomic gases, such as chlorine. A

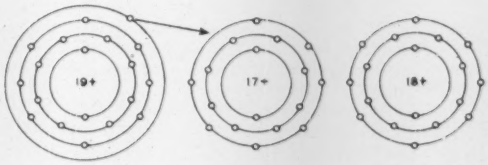

FIG. 1

covalent bond is one formed by two atoms sharing electrons in such a way as to account for the stability of each in attaining the rare-gas configuration. Thus in the chlorine molecule each atom requires an electron to complete its outer shell, Fig. 2.

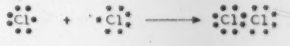

FIG. 2

In this molecule the positive attraction of the nucleus of each atom is equally great on each of the two negative charges of the shared pair. Substances formed by such bonds do not ionize in solution. In the case of carbon, it has an outer shell of four electrons which it will share in covalent bonds with other atoms to obtain a stable outer-shell structure of eight electrons. In the stable gas methane, it shares an electron with each of four hydrogen atoms, Fig. 3. In the form of crystal-

FIG. 3

line carbon (diamond) it shares an electron with each of four other carbon atoms.

There is a special type of covalent bond which involves sharing of electrons by an atom in a normally stable compound with other atoms. For example, the sulphur atom in dimethyl sulphide has formed two normal covalent bonds with two carbon atoms to bring about the completion of its full complement of eight electrons in its outer shell, Fig. 4. However, this

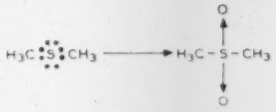

FIG. 4

compound can take on two oxygen atoms to form dimethyl sulphone; in this compound the sulphur atom is sharing four of its electrons with two oxygen atoms in addition to sharing its other two electrons in normal covalent bonds with carbon. Such bonds formed in normally saturated compounds are called co-ordinate covalent bonds.

Contributed by the Wood Industries Division and presented at the Wood Industries Conference, Jamestown, N. Y., September 27, 1949, of The American Society of Mechanical Engineers.

This same mechanism is used to explain another phenomenon occurring in organic molecules, namely, the chelate compounds. The peculiar properties of the hydrate of the sodium derivative of benzoyl acetone indicate that this substance may be represented by the formula in Fig. 5 in which the

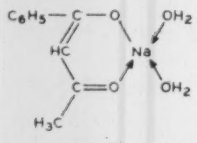

FIG. 5

arrow indicates that two electrons are contributed by each such oxygen atom. It will be noted that in effect seven electrons are being shared with the sodium atom to give it an outer shell structure of eight electrons. If the two molecules of water were present as water of crystallization, the compound should have the same chemical properties as the anhydrous salt. The anhydrous salt is insoluble in toluene, whereas the hydrate is soluble, indicating that a different compound has been formed by co-ordinate covalent bonding with the water molecules.

Similarly, evidence indicates that the phenolic hydrogen in salicylaldehyde is itself linked to the oxygen of the aldehyde group by a co-ordinate covalent bond, Fig. 6. This leads to a

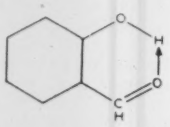

FIG. 6

very important case of this type of bonding, namely, the formation of hydrogen bridges between molecules. Many substances containing hydroxyl groups exhibit this structure, and even water has been shown to have a trimeric structure in ice. Thus co-ordinate covalent bonding may be an important factor in adhesion between substances containing hydroxyl or related groups.

Metallic Bonds. As the name indicates, these are the type which hold the atoms of metals together. A pure metal consists of a crystalline arrangement of metallic cations with free electrons moving in the interstices in a continuous set of energy levels. Thus a metal structure is relatively homogeneous and nonpolar. However, because of its freely flowing electrons a metal has mirror-image forces induced at its surfaces which are equal and opposite to the polar forces of an adhesive used on it. Therefore, in so far as polar properties are concerned, an adhesive would have as great an affinity for a metal as it would have for a material of polarity comparable to its own.

SECONDARY BONDS

Van der Waals' forces are responsible for the so-called secondary bonds between substances, as contrasted with the primary bonds—electrostatic, covalent, and metallic—which are based upon the potent forces of attraction between atomic nuclei and orbital electrons. When such primary bonds are formed, the positive and negative charges of the participating atoms are not completely neutralized. There remain in many molecules residual energies which are very nearly of stable bond-forming magnitudes. Van der Waals provided equations for calculating the magnitudes of these residual attractive forces for all substances. These forces are greater for the molecules of compounds than for molecules of elements or inert atoms, thus indicating that unequal distribution of charges accounts for the larger residual-force field. The more asymmetric the molecule, the greater the van der Waals' forces will be. These secondary bonding forces are of considerable significance in the adhesive behavior of complex substances.

Van der Waals' forces can be attributed to three different effects: (*a*) The orientation effect of permanent electric dipoles; (*b*) the induction effect of permanent dipoles on polarizable molecules; and (*c*) the dispersion effect of internal electron motions independent of dipole moments. These effects can be better understood by considering the geometry of molecules and their behavior in an electric field.

Orientation Forces. Molecules in which the centers of mass of the positive and negative charges are not coincident because of asymmetric internal structure possess an electric moment, i.e., they have an electric dipole. In the organic field, molecules containing oxygen, nitrogen, sulphur, and halogen atoms possess permanent electric dipoles. Such molecules tend to orient themselves in a uniform electric field, attempting to align themselves with the dipole axis parallel to the direction of the field. Even without an applied electric field, dipole molecules can exert an orienting influence on similar molecules by attraction between the unlike poles of each.

Induction Forces. Molecules which do not possess a permanent dipole moment, with the exception of the inert gases, may be polarized by placing them in a uniform electric field. Since these two poles are produced only by the external field, the molecules are said to possess induced dipole moments. The permanent dipole of another molecule can serve to induce the field. The dipole molecules are, of course, also polarized additionally by the external electric fields. These induced forces are small compared with the orientation and dispersion forces involved in secondary bonds.

Dispersion Forces. Forces of attraction exist even between atoms of the inert gases in which there is spherical symmetry of the charge shells and hence no orientation or induction effects. These pure dispersion forces are attributable to the interactions always occurring between electron systems because of constantly shifting electron positions. They are present in all molecules as residual valence forces. These dispersion forces are never as powerful as the orientation forces.

De Bruyne[1] has pointed out that the orientation and dispersion forces correspond, respectively, to those operative in the hydrophilic or polar liquids (such as water), and the hydrophobic or nonpolar liquids (such as benzene). The fact that these two liquids do not mix is attributable to the strength of the orientation forces between the permanent dipoles of the water molecules, squeezing out the adjacent benzene molecules. Similar considerations may be expected to apply to the interaction between an adhesive and an adherend. In general, strong joints to polar adherends are not obtained with nonpolar adhesives, and vice versa. Thus wood calls for hydrophilic or polar adhesives while rubber requires hydrophobic or nonpolar adhesives. Furthermore, nonpolar adhesives, which must rely mainly on dispersion forces, should not be expected to produce bonds as strong as those of polar adhesives which can possess orientation attractions many times greater than can be produced by dispersion forces. De Bruyne cites this as a possible explanation for the fact that the most effective method of rubber bonding appears to depend upon producing primary bonds, e.g., by the reaction of sulphur with both the rubber molecule and the adherend.

[1] "The Physics of Adhesion," by N. A. De Bruyne, *Journal of Scientific Instruments*, vol. 24, February, 1947, p. 29.

CHEMICAL NATURE OF SURFACES

A knowledge of the chemical nature of surfaces is necessary in order to understand the mechanism of bond formation between adhesives and adherends.

The surfaces of solids are entirely different from their internal structures. The simple treatments of grinding and polishing differ very greatly in their effects on surface nature. In metals, especially, x-ray diffraction patterns show that grinding removes sections of the surface without appreciable distortion of the remaining crystal structure, whereas polishing removes the promontories and deposits materials from them in the crevices, leaving a smooth transparent amorphous film known as the Beilby layer. This layer has more of the characteristics of a liquid than a solid and is much more reactive. If, for example, a metal vapor is condensed upon a polished metal surface, a crystal pattern is first obtained, but on standing this changes to that of a completely amorphous structure. If a nail is hammered into a crystalline surface, the amorphous ring around the hole will be more readily attacked by acids than the remainder of the surface. Glass surfaces when polished are rendered doubly refracting to a depth of 3000 A.

Solid surfaces are very irregular in their constitution. Thus the surface of even a monocrystalline metal will contain different faces, edges, corners, and projections. For this reason all parts of a given surface will not have the same catalyzing ability and, consequently, the same degree of affinity for adhesive substances. Experiments show that different faces of the same crystal exert very different forms of attraction upon dyes. Thus, if lead nitrate is immersed in a solution containing methylene blue and picric acid, some of the surfaces will be blue and some yellow; neither film is contaminated with traces of the other dye.

The greater the activity a surface possesses, the more likely it is to be contaminated with impurities which are present in the air. Freshly split mica surfaces will seize each other tenaciously, but if they are freely exposed to circulating air currents they lose this activity after a few minutes. It has been demonstrated that if these surfaces are covered, they will retain their attraction for each other for several days. Accidental traces of grease will reduce greatly the wetting properties of such surfaces, and even slight contamination will increase the contact angle with a liquid.

It has long been known that the affinity of the surface of a solid substance for a liquid is directly related to the shape of a drop of the liquid on a smooth surface of the solid. No liquid is known to make an angle of contact of 180 deg with a solid; this means that there is always some force of attraction between a liquid and a solid. When the liquid wets the solid, the angle of contact is small or zero. The best adhesion is given by adhesives which wet the surfaces of the adherends, in other words, adhesives which have a greater adhesive attraction for the adherend surfaces than cohesive attraction within themselves. The forces governing the wetting of surfaces are the van der Waals' chemical attractions (orientation, induction, and dispersion) discussed previously.

PHYSICAL FACTORS IN ADHESION

As mentioned in the introduction, the physical factors which affect the strength of bond between an adhesive and adherend involve (1) closeness of contact, (2) surface area, and (3) stress conditions.

CONTACT

The physical character of the surface of the adherend and the physical state of the adhesive must be such that the molecules of the two materials can be brought into close enough contact for the molecular forces to become operative.

Adherend Surface. The surface of the adherend must be clean and sound. It is well recognized that a clean surface is necessary to obtain adhesive bonds of maximum strength. This is definite recognition that adhesion is specific. Most workers in adhesives try to remove all the loose dirt and grease, but certain types of strongly bonded foreign material, such as adsorbed liquids and gases, are very difficult to detect and to remove. These foreign materials on an adherend often are decisive factors in determining whether or not a particular adhesive will bond to a particular adherend.

A sound surface is one which is free of poorly bonded foreign matter, but is not necessarily of the same composition as the bulk of the adherend. An anodized skin on aluminum is an example of a sound surface layer differing in composition from the rest of the adherend. However, in dealing with systems of this type, difficulties in interpretation will be encountered if it is assumed that the molecules of the adherend are bonded directly to the molecules of the adhesive. There is no doubt that the presence of a sound foreign surface on an adherend which was thought to be pure has obscured the actual seat of adhesion in some investigations.

Adhesive Surface. The physical state of the adhesive must be such that the molecules can come into close contact with the surface of the adherend so that the molecular forces can become operative. This molecular nearness can be obtained in several ways: (1) The adhesive molecules can be synthesized in contact with the adherend, as in the case of monomers which polymerize or condense to form a solid adhesive in situ. (2) A solid material can be applied as a solution in a volatile solvent. (3) A solid adhesive can be liquefied by heating. (4) A solid material can be liquefied by applied pressure, becoming solid again when the pressure is removed.

SURFACE AREA

There are several methods commonly employed to increase the area of solid surface available for participating in the bonding operation. These include physical means, such as sandblasting and sandpapering, and chemical means, such as acid-etching and solvent attack. The process of anodizing, in addition to changing the composition of the surface of the metal, also serves to achieve a marked increase in surface area. It is known that such methods may yield surface areas as much as 25 times the original areas.

In order to obtain a strong joint, a smooth surface is more desirable than a roughened one, inasmuch as the depressions in the latter must be filled in addition to the gap between the two surfaces. Furthermore, if the surface is deeply scored, there is always a possibility that air bubbles will be trapped in the glue line. The existence of such points of interfacial discontinuity will cause high concentrations of stresses in the vicinity which will result in premature failure of the entire bond when external loads are applied. Thus sanding of wood surfaces with the finest grade of sandpaper immediately before gluing gives a much better bond than that obtained with glazed surfaces produced by planing or with roughly sanded ones. The effect of the sanding operation is a combination of cleansing and increase of surface area.

STRESS CONDITIONS

Although molecular attraction is the most significant factor in adhesion, the stress-strain behavior of an adhesively bonded joint is probably the most important factor in determining its strength under service or testing conditions. Readily deformable adhesive materials, such as rubber, flow or yield sufficiently at ordinary temperatures to avoid production of large residual stresses during the bonding operation. However, this type of adhesive does not produce the rigidity required for

structural applications and fails at low temperatures for the same reasons that rigid adhesives fail at ordinary temperatures, namely, inability to eliminate stress concentrations by yielding with the dimensional changes of the materials bonded.

Analysis of the factors responsible for the production of stress concentrations in a rigid bond must include the following:

1 Stress-strain characteristics of adherend.
2 Stress-strain characteristics of adhesive.
3 Dimensional changes in setting of adhesive.
4 Dimensional changes under service conditions.

Stress-Strain Characteristics of Adherend. The cohesive strength and the modulus of elasticity of the material to be bonded determine to a large extent the magnitude of the stresses which may develop in an adhesively bonded joint. Thus in bonding operations involving materials of low cohesive strength, such as felts and cardboard, failure of the adherend occurs before large stresses are set up in the adhesive or at the adherend-adhesive interface. Likewise, in bonding operations involving readily deformable materials such as plastic films, the adherend tends to flow or creep to relieve stresses in the joint. However, in many industrial applications of adhesives, the materials to be bonded have both cohesive strengths and moduli of elasticity which are higher than those of the common adhesives.

As the thickness of the material to be bonded approaches zero, the stresses set up due to its modulus characteristics also approach zero. Accordingly, it has been found possible to bond thin metal foils to other materials, whereas the same adherends in heavier gages would be incompatible. This stress-reducing factor is also utilized in the production of mechanical mixtures of materials in powdered form or in the form of fine filaments.

Stress-Strain Characteristics of Adhesive. The same considerations regarding cohesive strength and modulus of elasticity, which have been outlined for the adherend, apply in the case of the adhesive. Joint strength has been observed to be inversely proportional to the thickness of the glue line. This may be attributed to the fact that in bonding two pieces of the same material, the stresses set up in the bond as a result of restrained dimensional changes in the adhesive would be proportional to the thickness of the bond. The greater probability of flaws occurring in a thicker glue line has also been cited as a significant factor in this thickness-strength relationship. However, starved joints resulting from application of too little adhesive, particularly in the case of adherends with porous surfaces, lead to adhesive-film discontinuities and hence to stress concentrations.

Plastic or highly elastic adhesives will react to an external load to produce approximately uniform stress conditions in a bonded joint. However, with rigid types of adhesives, stress concentrations develop whose magnitude depends upon the geometry of the joint and the mechanical properties of the adhesive and adherend. This variation in the behavior of bonded joints can be visualized by inspection of Fig. 7 which shows the distribution of stresses in shear-test specimens. The concentration of stresses at the ends of the joint for lap-joint specimens and for the single scarf-lap specimen, prepared with materials of unequal modulus, is readily apparent.[2] If the two adherends are of equal modulus, the single-scarf joint is adequate to produce generally uniform stress conditions. For materials of unequal modulus, however, it is necessary to use a double-scarf joint in which the angle taper of each adherend is proportional to its modulus. These examples of stress concentrations in joints illustrate what happens at the bond in the case of adhesives and adherends of different stress-strain characteristics.

Dimensional Changes in Setting of Adhesive. In order to bring into play the molecular forces involved in adhesion, adhesives are generally in a liquid or plastic state at some stage during the bonding operation. To convert the adhesive to a fixed or hardened state, chemical or physical change is necessary, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, evaporation of volatile constituents, or cooling below the transition point. The decrease in volume which accompanies these chemical reactions, solvent losses, or temperature changes leaves residual strains in the joints. In order to keep these to a minimum, it is desirable that most of the contraction of the adhesive takes place while it is still in a plastic state. The bond sometimes may be maintained if the materials bonded are thin enough to permit the relief of stresses by bending or warping, either of which is undesirable.

When two materials are bonded together at high pressures, strains are produced at the bond when the pressure is released. This strain is proportional to the ratio of the moduli of elasticity of the two components. The lowest pressure feasible should be used to produce bonds with the lowest internal strains.

The bonding strength exhibited by a particular adhesive is the additional load which, added to the internal residual stresses, is sufficient to disrupt the bond. In some cases this additional load is zero and the materials are said not to bond.

Dimensional Changes Under Service Conditions. There are four major factors which lead to dimensional changes in service and hence to the development of internal stresses in adhe-

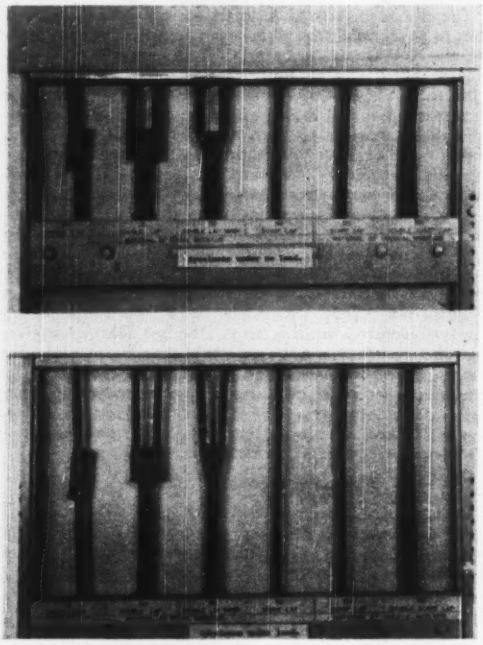

FIG. 7 DISTRIBUTION OF STRESSES IN SHEAR-TEST SPECIMENS (From Jackson, footnote 2.)

[2] "Efficiency of Lap Joints. Graphical Study of Physical Factors," by C. C. Jackson, Chrysler Engineering Laboratories, Report No. 4904, February, 1943.

sive joints, namely, temperature variation, humidity variation, loss of volatile or soluble components, and chemical reaction.

Inorganic materials such as glass and metals are characterized by relatively low coefficients of thermal expansion, whereas organic materials in general have high thermal-expansion coefficients. Hence stresses are developed in joints prepared with these two types of materials when the temperature differs appreciably from that at which the bond was formed. If the molecular cohesion of one of the materials is sufficiently low, the stresses developed at the glue line can be relieved by flow. However, such materials usually undergo excessive flow at temperatures above the softening point and have poor bond strengths. For materials which have high molecular cohesion and hence undergo very little flow, such as the thermosetting resins or most materials at low temperatures, the stresses developed because of different thermal-expansion coefficients are not readily relieved by molecular flow.

Large changes in moisture content of adhesives and adherends may occur because of relative-humidity variations normally encountered, ranging from the dry heated atmospheres (about 10 per cent relative humidity) indoors in winter to the damp condensation conditions which may persist for long periods at other times during the year. The problem of internal stresses attributable to dimensional changes of materials sensitive to relative humidity can be reduced, if not eliminated, by application of a surface material impervious to moisture. Moisture-sensitive materials should be bonded in such manner that, at the end of the bonding operation, they contain the normal amount of water present under average conditions.

Loss of volatile components, such as plasticizers, or water and solvent soluble materials, leads to shrinkage of the adhesive or adherend and the introduction of internal stresses. Likewise, further curing of thermosetting resins is a frequent source of shrinkage which leads to failure of adhesive bonds in service.

All of these various causes of stress concentrations in joints between adhesives and adherends must be considered in the design of adhesively bonded structures and the selection of materials for specific jobs.

OTHER FACTORS IN ADHESION

Molecular Weight. The highest bond strengths are usually observed with polymers of intermediate molecular weights. The low-molecular-weight materials fail in cohesion rather than adhesion. The high-molecular-weight materials have low bond strengths because (1) the adhesive does not flow sufficiently to make good contact with the adherend, or (2) if drastic bonding conditions are used to make the adhesive flow to make contact, the adhesive becomes too rigid to relieve stresses developed on returning to room conditions, thus lowering the bond strength.

McLaren and Seiler[2] showed that, provided the molecular weight is high enough so that cohesive failures do not occur, the adhesion is independent of the molecular weight. However, it seems reasonable to expect that in a case where adhesion depends on end groups, an increase in molecular weight would result in a decrease in adhesion.

Molecular-Weight Distribution. A low-molecular-weight fraction in a polymer tends to act as a plasticizer. The flow characteristics are increased, making the relief of stresses more likely. This effect, however, can be carried too far and result in a polymeric adhesive with low cohesive strength.

Plasticizers. The addition of plasticizers to a polymeric material results usually in a decrease in cohesive strength and an increase in flow characteristics. By choosing the proper amount and kind of plasticizer, it is often possible to convert too rigid a polymer with many other desirable characteristics into a good adhesive. The addition of a plasticizer of a different chemical type may affect the molecular forces responsible for the adhesion. By addition of the proper plasticizer, it is often possible to increase or decrease the adhesion of a specific adhesive-adherend system.

Tack-Temperature. The tack temperature is related to the flow characteristics and to the molecular weight of the polymer in question. The tack temperature is indicative of the region in which the material flows more or less readily. It is apparent that a material with a low tack temperature will have low cohesive strength and one with a high tack temperature will not have the requisite flow characteristics. Hence an apparent relation between tack temperature and adhesion would be expected.

Adsorbed Materials. An adhesive will sometimes bond only to certain random areas of an apparently clean adherend, or good bonds will be obtained with one lot of adherend and not with another similar lot. These inconsistent results often can be explained by the presence of adsorbed gases, water, oil, or other materials on the surface of the adherend which are difficult to remove and are not visible to the eye. Special cleaning, storing, and handling techniques are often needed to obtain reproducible results.

Porosity. The porosity of a surface can affect the adhesive in many ways. If the liquid adhesive flows into the pores and solidifies so that the surfaces of the projections maintain contact with surfaces of the pores, an increase in adhesion will be observed because of the increased area of contact over that presented by smooth surfaces. If the projections are tight in the pores, an increased strength may be observed in shear tests because of the mechanical effect. Mechanical effects of this type are not common. The major part of any increased strength is attributed to the increase in area of contact.

The presence of pores may also cause the bond strength to decrease: (1) A porous surface is harder to clean. (2) Porous surfaces are often not sound; the material has a low cohesive strength and failure in cohesion rather than adhesion is encountered. (3) It is more difficult for the adhesive to wet the surface, particularly if it is not sufficiently fluid in the application stage. (4) Gases may be trapped in the pores hindering contact between adhesive and adherend at these places.

Prime Coats. It is sometimes desired to bond materials together for which no suitable common adhesive is available and which do not bond to each other. A prime coat is often applied on one or both of the materials in such cases. The primer in this instance is an intermediate adhesive between the adherend and the adhesive proper. The principles which apply to adhesion apply also to these prime coats or primers.

SUMMARY AND CONCLUSIONS

Bonded joints often may be designed in accordance with the fundamentals discussed herein so that stronger bonded assemblies are obtained. Particular attention needs to be given to the design of test specimens and procedures for evaluating adhesion and to interpretation of test data in terms of the chemical and physical factors involved in adhesion. Recent contributions to our knowledge of adhesives and adhesion are listed in the appended Bibliography.

ACKNOWLEDGMENT

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[2] "Adhesion. III. Adhesion of Polymers to Cellulose and Alumina," by A. D. McLaren and C. J. Seiler, *Journal of Polymer Science*, vol. 4, February, 1949, p. 63.

Research on the nature of adhesion and the mechanism of adhesive action. This review of the fundamentals of adhesion has been prepared in connection with the planning and interpretation of the experimental portion of this investigation.

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ALUMINUM SEAMLESS TUBING

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EARLY PROCESS

UNTIL 25 years ago aluminum seamless tubing was made from flat stock starting with circular plates and a cupping press. Thus by frequent cupping and annealing, the plates were formed into short cylinders suitable for further reduction. Then by use of a drawbench and with more draws and further anneals the cylinders emerged as tubes. At that time, drawbenches were driven by belt, chain, or rope drives from a central power source and, since the hook on the tongs truck had to be engaged in the draw chain by hand, speeds were necessarily slow. Needless to say, with short starting lengths from the cupping press, slow bench speeds, and many anneals, the manufacture of aluminum tubing was slow and costly.

Today aluminum seamless tubing is fabricated directly by the extrusion process employing a through-mandrel, or by cold-drawing an extruded bloom (see Figs. 1 and 2). The extrusion process lends itself quite readily to the direct fabrication of tubing which does not require a drawn finish, exacting tolerances, and intermediate temper or refinement of the metal structure obtained by cold work. Although large quantities of tubing are now fabricated directly by extrusion, employing a through-mandrel, this paper will deal with cold-finished tubing produced from an extruded bloom.

Since the extrusion process becomes more costly as the ratio of diameter to the wall thickness increases, the extruded bloom produced for cold-finishing is confined to a few economical stock sizes of relatively heavy wall. It is then cold-worked to produce the size, tolerance, finish, intermediate tempers, or refinement of metal structure necessary for the finished product.

PRESENT CLASSIFICATIONS OF COLD-FINISHED SEAMLESS TUBING

At the present time there are two general classifications of cold-finished seamless tubing produced, and two major processes in use to perform the sizing operation and supply the necessary cold work. The classifications are divided into nonheat-treatable alloy tubing, which may be marketed with any degree of cold work but more commonly is supplied as annealed, 1/4 hard, 1/2 hard, 3/4 hard, and full hard tempers; and the heat-treatable alloy tubing which is usually sold in the heat-treated or annealed condition. The cold-working methods by which proper tube size and temper are obtained consist of the tube-reducing process and the cold-drawing process. Although the tube-reducing process conceivably can be used to produce tubing of any commercial wall thickness and diameter, it is considered particularly suitable for the manufacture of the middle range of tube sizes and of strong alloy tubes. The cold-drawing process, on the other hand, is suitable for the production of tubes in all alloys and all sizes.

To understand the production of tubing more thoroughly it will perhaps be well to discuss some of the basic principles. The cold-drawing process will be discussed first since it is the most generally used method.

Cold-Drawing Process. Crude directions for carrying out the cold-drawing process could read as follows: First drill a tapered hole in a piece of steel, which will serve as the die.

Based on a paper originally contributed by the Metals Engineering Division to THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

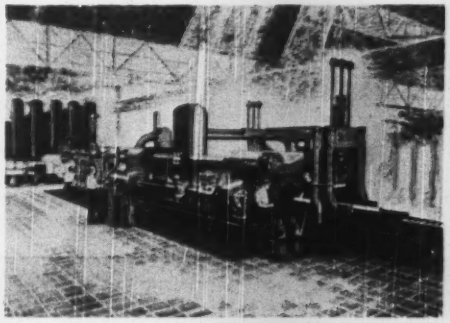

FIG. 1 GENERAL VIEW OF AN EXTRUSION PRESS

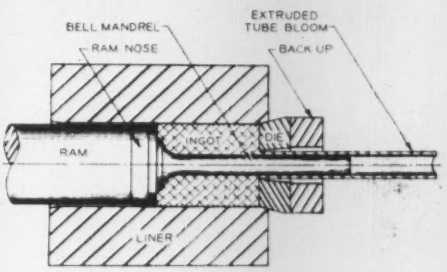

FIG. 2 SCHEMATIC SECTIONAL DIAGRAM OF AN EXTRUSION-CYLINDER RAM AND DIE SHOWING A TUBE BEING EXTRUDED

Clamp this die in a vise, then select a piece of tubing larger than the small end of the tapered hole, hammer a point on the tube, coat it with a viscous lubricant, insert it in the tapered hole, and pull it through the die with a pair of pliers. By this means the tube would become elongated, the cross-sectional area of the tube would be reduced, and since no bulb or mandrel has been used, the wall thickness would increase. This method is known as sinking. Now let it be supposed that a rod or wire is inserted in the unpointed end of another tube of the same original size as the first tube, the wire or rod being larger than the final inside diameter of the tube previously sunk, and the tube again inserted through the die and both tube and rod are drawn through. This time the tube would be elongated, the cross-sectional area would be reduced, and a controlled reduction of wall thickness would be effected. This is known as rod-drawing. It will be seen readily that in this latter case the rod or wire must be extracted from the tube, possibly at the expense of considerable effort, since the tube is probably tightly drawn onto the rod. Therefore, suppose the rear end of the rod is fixed so that as the tube is drawn through the die it in turn slides over the rod. The tube would then be sized as before; however, the rod would be extracted during the drawing operation, Fig. 3. Although this is the basic prin-

ciple of today's cold-drawing operation, many improvements and refinements have been added.

Today's benches, Figs. 4 and 5, operate with draw speeds up to 300 fpm, and the tongs truck is returned to the die head at speeds reaching 400 fpm. Tungsten-carbide and hardened steel dies and bulbs replace the crude steel dies and rods previously noted, and the average bench will draw a tube well over 50 ft in length. To this are added other processes such as

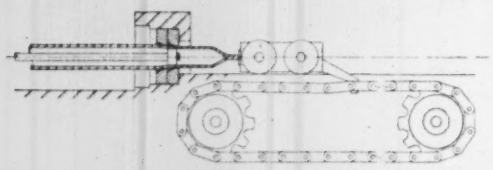

FIG. 3 SCHEMATIC DIAGRAM OF A DRAWBENCH, SHOWING A TUBE BEING DRAWN OVER A BULB OR MANDREL

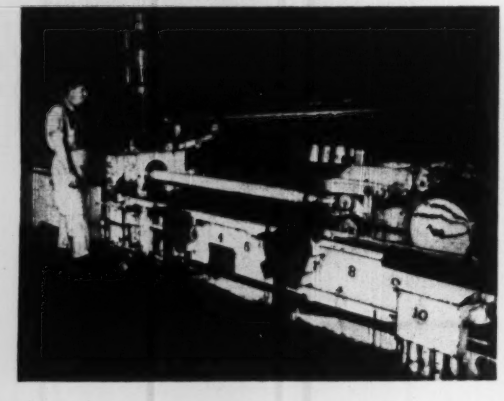

FIG. 4 DRAWBENCH RATED AT 100,000 LB PULL, DRAWING LARGE-DIAMETER TUBING

drawing tubing through a die by means of a coiling drum or drawblock, Fig. 6. In so doing a floating flared bulb may be used which is held in place by friction on the flare, or the tube may be sunk with reasonable control of the wall. In this process the length of the metal coiled is dependent only upon the starting lengths available and the reduction made. This process, however, is limited to the smaller range of tube sizes by the permissible coil diameters.

The cold-drawing process is exceptionally flexible in that a multitude of sizes can be produced on one bench with inexpensive tools and quick tool changes. Although it does not lend itself readily to mass-production methods, its adaptability is a decided advantage in producing small and varied orders. Disadvantages of this process are that lengths of tube produced are limited to the length of the machine and lengths that can be handled and threaded over a mandrel conveniently. Both large and small diameters are difficult to handle. The actual time the machine is drawing metal is small compared with the total cycle required, and the machine is inefficient from a power standpoint. Other disadvantages include the limitation of possible reductions per pass by the strength of the metal on the tension side of the die, the high scrap loss from points necessary to pull the metal through the die, and from breaks that occur from small handling marks or transverse scratches as the metal is stressed beyond its yield strength. In drawing metal whose yield strength is close to its ultimate strength, as is the case if large reductions are made without intermediate annealing, the possible scrap loss from tension breaks is even more critical, and, therefore, extreme care must be exercised in planning proper reductions and selecting proper tools.

Tube-Reducing Process. The tube reducer operates on an entirely different principle from that of the process just described. The reduction of outside diameter is effected by a pair of rolls or rockers, Figs. 7 and 8, that have been grooved about their circumference with a gradually increasing semicircular groove or trumpet shape. These rolls are then made to rock forward and backward over a conical or trumpet-shaped mandrel of somewhat smaller diameter than the circular groove between the rolls. The tube to be reduced is fed over the mandrel in increments at the end of each backward stroke of the rocking rolls or at the point of the largest circular opening between the rolls. The reduction is then made as the rolls rock forward toward the

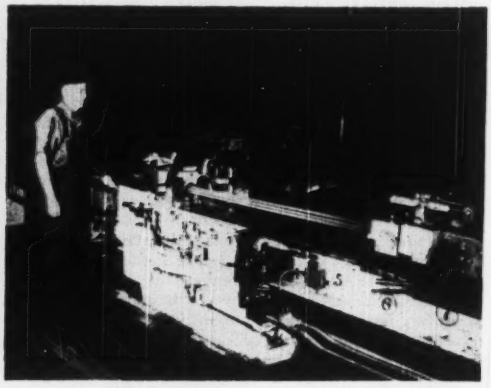

FIG. 5 DRAWBENCH RATED AT 7000 LB PULL SINKING SEVERAL SMALL-DIAMETER TUBES AT ONE TIME

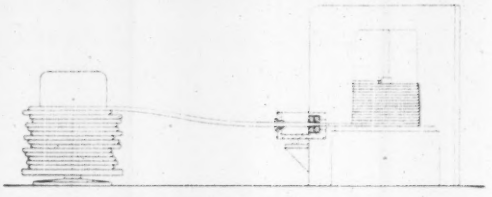

FIG. 6 SCHEMATIC DIAGRAM OF DRAWBLOCK DRAWING COILED TUBING

small end of the mandrel by gradually rolling the tube to conform to the opening between the rolls and mandrel. At the small end of the mandrel the roll grooves have been relieved or made larger, such that by a slight overtravel of the rocking rolls they may be rocked clear of the tube being reduced. At this point the tube is turned a few degrees about the mandrel and the larger imperfections of the tube surface are ironed out during the return stroke of the rocking rolls. As may be seen, this machine reduces tubing by an intermittent rolling operation and the forces involved are principally compressive.

By the use of this method a reduction considerably greater than that possible with the drawing operation may be made in one pass.

Although the basic processes used for the forming of seamless aluminum tubing are of primary importance, they are in themselves only a means of producing a seamless tubular shape. The other operations, of importance and interest are pointing, cleaning, annealing, solution-heat-treating, straightening, and cutting which are essential in many cases before tubes are ready for final inspection and subsequent shipment.

DETAILS OF MANUFACTURE

Before each drawing operation, tubes must be pointed for insertion through the die as previously noted. This operation is usually performed by an air hammer or swager, the hammer being used on large-diameter tubes and the swager on the smaller sizes. Although the hammering operation may be done cold, heating of the tube point helps to prevent cracks and tends to form a more sound point. Since the hammer is slow, the swager is used on smaller sizes, its chief disadvantages being high maintenance, noise, and the difficult feed problems involved.

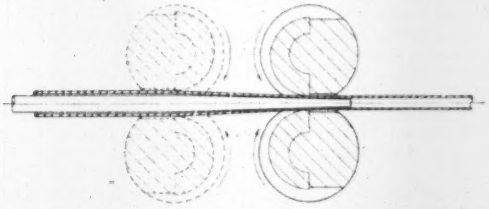

FIG. 7 SCHEMATIC DIAGRAM OF TUBE REDUCER SHOWING ROCKING DIES IN THEIR BACKWARD AND FORWARD POSITION WHILE PRODUCING TUBING

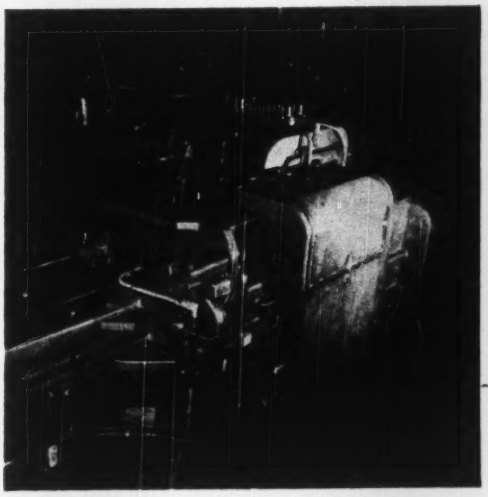

FIG. 8 ROCKER HEAD OF A TUBE REDUCER WHICH CARRIES AND ACTUATES THE ROCKING MOTION OF THE DIES

To produce tubing on which several reduction operations must be made it is essential to have an intermediate anneal to eliminate the strain-hardening from the reduction already made and thus permit further reduction. This work is usually carried on in a forced-circulation convection-type ,batch furnace. The heat source for such furnaces may be electricity, gas, or oil, depending upon availability of the fuel and its cost. Although a continuous-type furnace is practicable for large-tonnage items, the batch furnace is most economical where a large variety of alloys and sizes, each of limited tonnage, is produced.

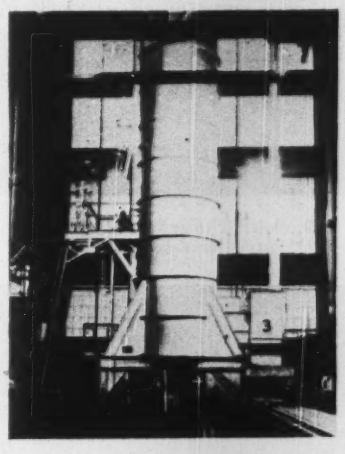

FIG. 9 VERTICAL HEAT-TREATING FURNACE SHOWING LOAD BEING RAISED FROM PIT INTO FURNACE

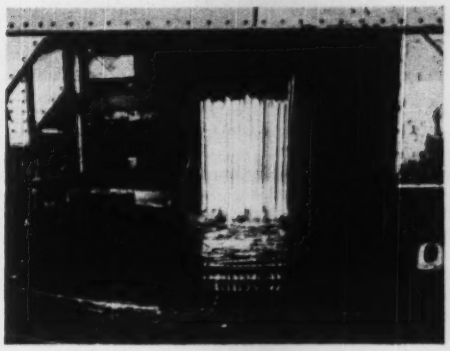

FIG. 10 VIEW SHOWING CLOSE-UP OF HOW LONG TUBING IS QUENCHED IN PIT BELOW FURNACE

Since the lubricants used in drawing often produce a carbonaceous deposit or stain on the surface of tubing during anneal, an intermediate cleaning operation is usually necessary. This cleaning operation may be performed in many of the aluminum cleaning solvents now offered by the trade. However, because of the difficulty of reaching the inside surface of long tubes, a nonfoaming liquid such as mineral spirits or trichloroethylene is perhaps the most universally used. A strong circulating current in the solvent bath is also desirable to aid in removal of dirt and oil from the inner surfaces.

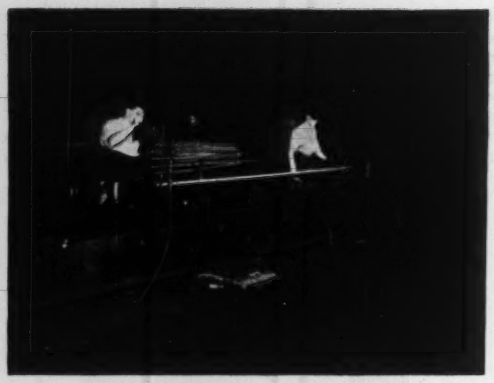

FIG. 11 VIEW SHOWING TUBING BEING STRETCHED IN A HYDRAULIC-OPERATED STRETCHER

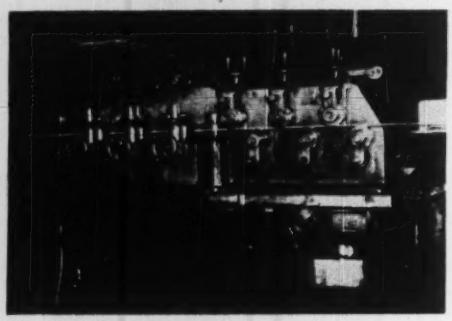

FIG. 12 TWELVE-ROLL STRAIGHTENING MACHINE SHOWN STRAIGHTENING SMALL-DIAMETER TUBING

The solution-heat-treating operation, Figs. 9 and 10, is usually carried out in batch-type furnaces. Satisfactory results can be expected only if very close temperature control is achieved, for which reason these furnaces are of special design. They are usually constructed in a manner that will insure uniform heating of all parts of the load. Another necessary feature is that the quenching medium be located as close as possible to the furnace to insure a fast and uniform quench.

STRAIGHTENING METHODS

Before tubing is cut to length and sent out as a final product, a straightening operation is generally necessary. Various methods are used depending upon the dimensions of the product and on the equipment available.

The hand or power-press method is usually employed for very large tubing and for tubing other than round. It utilizes simple bending methods. Straightedges and the human eye are the gages used to insure straightness. Both simple arbor presses and hydraulic-operated presses are used in this operation.

The stretching method, Fig. 11, is employed for longitudinally straightening both round and other than round tubing. Machines to perform this operation consist of a stationary jaw to grip one end of the tube and a movable jaw attached to a hydraulic cylinder for gripping the opposite end. The metal is then stretched slightly beyond its yield strength and emerges longitudinally straight. Although this operation appears simple, it is also critical in that stretching slightly reduces the wall thickness and diameter. Since this change of dimensions results from cold-working, there is a corresponding change in physical properties known as strain-hardening, and allowances must be made to meet the change during the reduction operation. It is worthy of note that this condition can result in an advantage or disadvantage depending upon the physical properties required, and the dimensional tolerances allowed. For example, metal produced slightly over the allowable dimensional tolerance can be brought within these tolerances if the physical properties are not exceeded. Likewise metal slightly low in physical properties can be corrected if the dimensional tolerance is ample.

The roll-straightening operation may be divided into two classifications: A twelve-roll machine which produces longitudinal straightness only, and a five-roll machine which combines longitudinal straightness with a truing operation of the cylindrical shape. The first machine noted, Fig. 12, may have twelve or more rolls grooved to the tube radius, one half of the rolls being mounted in an opposed but staggered manner in a plane vertical to the tube axis, and the other half staggered and opposed in a horizontal plane. As the tube is passed through this sytem of rolls, internal stresses are equalized by induced alternate bending strains, and the tube emerges longitudinally straight. Since this requires a complete set of rolls for each size of tube and has little effect on the shape of the tube, it is used principally as a preliminary straightening operation for round tubes and for a finish operation on rectangular-shaped tubing.

The five-roll machine, on the other hand, Fig. 13, is used as a finishing operation on practically all round tubing produced. The machine consists of two large driven rolls with concave faces mounted in tandem, their axes inclined at an angle to, and crossing the longitudinal axis of the tube being straightened. Three similar idler rolls are mounted in an opposed but staggered manner to the driven rolls, inclined at an equal but

(*Continued on page 732*)

FIG. 13 VIEW OF FIVE-ROLL ROTARY STRAIGHTENING MACHINE STRAIGHTENING LARGE-DIAMETER TUBING

MACHINES *and* FORESTRY

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INTRODUCTION

THERE are both engineers and foresters who should be thinking about machines in forestry. Although the reasons for this may be better known to the foresters, those reasons are important to all who are dependent upon wood as a raw material for any purpose. A brief review of the changing forestry situation of the United States will assist in showing that new and better machines are required.

THE FORESTRY SITUATION

Although improved forest management applied to date is paying dividends by currently increasing growth of young forests, the annual volume of trees of saw-timber size which are cut and destroyed by fire, disease, and insects is substantially greater than the volume of young trees which annually reach saw-timber size.

Wartime and postwar demands for saw timber and wood for other purposes led to the construction of hundreds of miles of roads into previously inaccessible timber stands. Since 1942, 3100 miles have been built by the U. S. Forest Service; loggers and timberland owners have constructed hundreds of additional miles. Still more miles of access roads will be required to reach all of the timber stands that are at present inaccessible, but those virgin stands represent no unlimited or inexhaustible supply. It is good business for both public and private owners alike to aid nature in every way practicable by good forest management to insure regrowing of an adequate quantity of quality timber. The foreseeable exhaustion of virgin forests does not mean exhaustion of the forests because timber is a crop, but it does emphasize the importance of proper forest management in raising new forests to insure adequate future supply.

While wood is as important to the economy of the country as coal, iron, and other natural resources, the forest resources are different in that they are renewable. If present forest land is placed under proper management, and protected against fire and other losses, the forests will furnish an adequate supply of wood in perpetuity.

The transition now in progress is from placing primary dependence on nature to plant and grow forest crops with a little aid, to intensive forestry, where man takes a hand. Intensive forestry involves such measures as care of soil, collection and treatment of seed, controlled seeding, nurseries, tree planting, thinning, pruning, more unremitting protection from fire, insects, and disease, and carefully planned harvesting. The attention to growing tree crops is similar to that accorded the raising of farm crops. The number of professional foresters engaged in managing forest lands certainly reflects that the transition is under way. Since 1941, professional foresters engaged in private or industrial forestry have increased approximately 300 per cent, to a total of about 3000.[1] When we add to this latter figure the professional foresters employed by public agencies, we find that about 12,500 are engaged in this work.

Other trends are the growing recognition of the need for adequate protection from fire, insects, and disease. Losses due to inadequate protection are still more than we can tolerate. In regard to fire, we find that the average annual burn on the national forests from 1941 to 1945, was 0.17 per cent of the acreage under protection. This would be a good record if evenly distributed. However, a low national rate often obscures high regional or local damage. Even when local average losses remain small, a large fire once in 25 years may be more than the local economy can stand. It should be noted here that a large portion of the forest land in the United States still has no organized protection.

Growing public recognition of the important influence that soil conditions and cover crops have on erosion and flood control, and on water yield is making it necessary that forest-land managers take suitable measures to meet the needs of over-all soil conservation, flood control, and water-production plans.

By and large, the forester is doing a good job in developing silvicultural and management methods designed to grow the needed quantity and quality of timber. But the rate of adoption of many of these intensive forestry practices no doubt has been greatly retarded because of the lack of low-cost means of putting them into effect on a broad scale. Wages for all types of labor have gone up in forestry as in other lines of industry. For example, in some western regions of the Forest Service, it is necessary to pay fire fighters 250 per cent of the wages paid for the same work in 1940. There is little doubt that wages for hand labor in planting, thinning, pruning, slash disposal, and similar operations account for the major share of these costs.

Here we find one of the principal bottlenecks to more rapid progress in adopting the needed forestry practices. What can machines do to help break this bottleneck? Has mechanization kept pace with the changing forestry situation and other developments in forestry?

EXTENT TO WHICH FORESTRY IS NOW MECHANIZED

Let us examine briefly a few of these operations. In reforesting areas the situation is about as follows:

Seed Collection. This is expensive. It is largely a hand job and comparatively slow.

Artificial Reseeding. Artificial reseeding of areas that will not reproduce naturally has not yet become a dependable method, although such work has been carried on in a limited way for many years.

Broadcast seeding by hand can now be replaced by seeding from airplanes, and a start is being made on speeding up large operations by air under specific conditions. But techniques are not fully worked out, and results are variable. Rodents are usually a big problem in the success of such work in the West. Treatment of the area for control of rodents by air is also being attempted on an experimental basis.

Mechanical seeders or drills, now available, are suitable only where terrain is not too steep or rough or where stumps, logs, slash, and rock are not problems. Pelletizing seed helps primarily in providing uniform-sized particles for mechanical distributors and aids in obtaining more uniform distribution. Un-

[1] "Practice of Forestry on Private Lands in the U. S.," by C. F. Korstian, Durham, N. C., 1889. Seeman Printery, 1944. Duke University School of Forestry, Bulletin No. 8.

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fortunately, pelleting material used so far often inhibits germination.

Planting of Nursery-Grown Stock. Under most conditions this has many advantages over direct seeding. Most equipment in tree nurseries is custom-built to accommodate seedbed widths. Up to the present time, the amount of nursery equipment has not justified standardization. But if nurseries continue to expand, some attempt should be made to adjust nursery-row spacing to standard-gage tractors and attachments, or to establish equipment standards for all tree nurseries.

For transplanting in tree nurseries, a modified Holland celery transplanter has proved quite suitable. However, mechanical engineers might find many opportunities for further improvement.

Preparation of Planting Sites. This often requires removing brush and small trees of inferior species.

Except for the bulldozer, which sometimes does considerable damage from a watershed and erosion-control standpoint, little has been done to provide suitable mechanical equipment for this job. A machine is needed which will cut the brush, chop it up, and spread it, or mix it into the soil. The use of the machines tried so far is limited by slope, roughness of terrain, and high operating costs. The fact that the available machines are cumbersome and require a lot of man-hours for maintenance often has considerable influence on operating costs. Of most importance, however, is the fact that there is no machine suitable for the preparation of a great many planting sites. One of the big equipment jobs connected with reforestation is to develop a machine that will clear and prepare rough land, often with lots of stones, rocks, or stumps, and covered with up to 4-in-diameter scrub oak or equivalent forest or brush cover.

Tree-Planting Machines. Several types of such machines are now employed successfully where the terrain is not too steep or rough and where brush, stumps, and rocks are not problems. A great many more tree-planting machines might be used if a machine could be developed for use over a wider range of ground conditions.

Much of the land that should be planted to trees is side hill rather than rolling. A planter attachment that could be made integral with the tractor rather than tied on behind, thus making it a self-propelled planting unit might be a solution. One thing is certain, there is at present no planting machine suitable for widespread tree planting on the rougher lands.

Even with their inadequacies, tree-planting machines on the market enable one to get three times as much production per man-day as by the usual hand methods. They are not fully automatic and working one is no sinecure. They are not popular with the worker who can find other employment.

The foresters have made commendable progress in adapting truck-gardening machines to tree farming, but we need some good tree-farming machines built from scratch, not just by adapting and converting celery planters and road scrapers.

Thinning. In natural stands as well as in seeded or transplant stands, the saw-timber yield per acre can be increased greatly on some lands by thinning, and there is a tremendous job of this kind to be done. Thinning may consist of cutting out saplings or treating small and large trees of unwanted species so that subsequently they will die. When the trees to be eliminated have no sale value, the job must be done cheaply, but no machines or small powered tools have yet been found fully suitable for thinning operations.

Use of small tractor dozers for cutting swaths is not selective. Also this too often results in considerable damage. Both girdling and chemical treatments by hand, injection, or spraying devices are slow and costly. The design of a successful thinning tool or machine is a real challenge to inventors.

Pruning. Like the orchardist, the forester may engage in pruning. Pruning to a height of some 20 feet will greatly improve the quality of timber in some stands. This is done by hand to some extent but would be a much more feasible practice, economically and otherwise, if the job could be mechanized.

Some attempts have been made to devise pneumatic and electrically driven power shears and saws. Success has not been outstanding owing to the size of the power plant required and because cables and hose invariably become entangled among the lopped limbs, standing trees, and other debris. In many cases this power equipment has proved uneconomical. At least one attempt has been made to develop a tree-climbing power saw. This appears to have good possibilities but has not as yet progressed past the blueprint stage.

Elimination of weed trees and undesirable species involves very much the same problems as thinning. Present methods include axe girdling or cutting out notches and applying ammate, hand-drilling holes, and filling with ammate or sodium arsenate, or chemical spraying.

The foresters are waiting to welcome the inventor who will develop the machinery to make thinning and weeding economically feasible when labor costs are high.

Harvesting. Or, in plain English, the logging job, is by and large one of the most highly mechanized forestry operations. But even here the foresters are seeking improved and different types of equipment.

Power saws, high lines, slack lines, boom lines, cranes, tractors, arches, logging trucks, and other special items of logging equipment developed in the last quarter-century have greatly facilitated logging and, in a great many cases, have also led to better timber utilization and to leaving the stands in better shape.

But there are still places where more suitable equipment is needed for skidding and yarding. Sometimes it is a question of cost; sometimes there are other factors which make the use of existing equipment unfeasible.

There are places where tractor or tractor and arch logging by conventional methods is detrimental to watershed lands. The care with which present-day equipment must be used materially increases costs of logging in some areas. Here again the foresters are seeking something different and better in the way of forest machinery. For example, on at least one selective logging operation in the United States, the logs are transported from the stump to the truck road by gravity while suspended from a high line.

The important features of this installation, which is manufactured by a Swiss concern, are the single drum, lightly powered hoist, and the arrangement by which the hook carrying the load is automatically released from the carriage when the latter is pulled against a stop on the standing line near logs to be moved. When the hooked log is raised to the carriage, the hook automatically locks in the carriage. The carriage then rolls along the cable to the foot of the hill or to the truck road by gravity.

The blocks used in this particular installation are designed for 4000-lb loads and there are other features which keep it from being a uniformly acceptable alternate for tractor skidding. Nevertheless, watershed disturbance is avoided, and we see that there are other ways to log with machines if we can think of them and develop them.

Logging equipment is far too big a subject to be covered in a few paragraphs. The equipment engineers have gone a long way in developing machines to do the harvesting job but we are still looking for improvements for many special cases.

Slash Disposal. A problem that is directly associated with harvesting and that has not been solved yet is slash disposal.

Present costs are often very high for disposing of slash in a manner that is not detrimental to the soil, or opposed to good flood and erosion-control practices, and that will at the same time reduce fire hazard to a safe degree. The present methods include hand-piling and burning, bunching by means of tractors with special rake-toothed blades, broadcast burning, or providing greater fire protection to offset the high fire hazard until natural elements have reduced the slash. Broadcast burning or leaving the slash on the ground may sound like cheap methods of slash disposal. This is not always the case. Broadcast burning is only safe where and when weather and other conditions permit. The burners must be prepared to prevent the fire from getting away and to stop it if it does. Slash left on the ground creates an additional fire hazard, and therefore usually increases fire-protection costs over a period of many years. Consequently, the foresters are still seeking machines that will provide better and cheaper slash disposal.

Road Building. A big part of more intensive forest management consists of expanding the road system. Roads are built and maintained for better forest protection from fire, insects, and disease; roads help to make sanitation cutting and proper selective cutting economically feasible. Road work is probably one of the most completely and adequately mechanized forestry operations. The equipment men have kept pretty well up with the foresters here. However, it must be admitted that the engineers came in late on the development of some forest road-building equipment. The foresters and loggers were building roads with makeshift bulldozers in the West while most road engineers were still wedded to the power shovel.

In the last 15 or 20 years, however, the automotive, mechanical, and civil engineers have pretty well mechanized road building. Forestry is well equipped with machines for that job. Nevertheless, the foresters are still looking for road machines that are cheaper to operate and with more versatility embodied in one machine.

Trails. The foot or horse trail is still important in forest-fire control in some parts of the country. The U. S. Forest Service maintains about 150,000 miles of these trails. No completely successful trail construction and maintenance machine has so far been able to compete widely with horses and hand work. Thus the foresters are still looking for an engineer to come up with a machine for the trail job.

Mechanization of Forest-Fire Control. This has progressed considerably in areas where steepness and roughness of terrain are moderate. In these areas, tractor-drawn fire-line plows, pumper-tank trucks, portable pumpers, all-wheel-drive vehicles, and many similar items have contributed greatly toward adequate protection. In steep mountainous areas present equipment is so limited that the major part of fire-line construction is done by hand labor. In some western regions of the Forest Service, over two thirds of the fire-suppression costs are for wages.

Tractor dozers are used to a large extent but much of their effectiveness is lost through slow transport to the fires. Helicopters, and parachuting from fixed-wing aircraft have done much to speed up and increase the effectiveness of hand labor.

Little has been accomplished toward providing powered fire-line construction equipment suitable for rapid transport. Just for example, one of the greatest immediate needs is on the order of a garden-type tractor with powered fire-line trencher or digger. Such a unit should be small and light enough to be transported in a pickup truck or dropped by parachute. The development of a fully suitable unit of this nature should save hundreds of thousands of dollars in fire-suppression costs annually. Similarly powered brush-cutting equipment to operate in areas too steep or rough for tractors is greatly needed. There are many other items that could reduce costs and aid in achieving the fire-protection objectives both nationally and locally.

Insects and Disease. These must be controlled more effectively if we are to continue to produce the needed quantities of desirable timber species. Much more of this work would be done if it were not for high labor costs.

Recent developments in insecticides and selective herbicides have been hailed as a great boon to work of this nature. Yet we are unable to take full advantage of these important chemical discoveries until some new types of self-propelled spraying equipment have been developed.

Where the insects or disease affect the foliage, air spraying provides a useful and economical medium but to control insects concealed in the bark or to eradicate undesirable ground cover underneath trees which act as alternate hosts for tree diseases, requires that the problem be met from the ground. At the moment, development of lightweight portable power-spraying devices, or improvement and adaptation of already developed equipment to the jobs at hand are sorely needed. For example, the Forest Service is planning a large-scale control project of spruce-bark beetle in the Rocky Mountain area. It is estimated that 750,000 trees, most of them inaccessible to roads and on difficult terrain, will need to be sprayed.

The project is possible at this time because of additional research on the life cycle of the insects and of recent developments in the chemical field, but it will be an extremely costly job because mechanical means are not available or adaptable in sufficient degree to be of maximum assistance on this job. This is a job which, like time and tide, simply will not wait.

By this time the reader, no doubt, is willing to agree that while forestry may be highly mechanized in some respects, mechanization has not kept pace with other developments in the field.

Silvicultural operations are least mechanized. These are the very forestry operations which should be expanded. Forest-fire fighting has been mechanized to a remarkable degree, but it still takes thousands of man-days every year and is costly.

WHAT SHOULD BE DONE ABOUT IMPROVING FORESTRY MACHINES?

How can we best attack the problems of mechanization in forestry? How shall we go about filling these equipment needs? Shall we bide our time until inventors and the equipment manufacturers come up with the answers? The author believes the foresters will agree that this approach will not do.

There will be little incentive for strictly commercial development until intensive forestry becomes so widespread as to create a profitable market for machines. Meanwhile that situation is not likely to occur until machines have been developed to make good forestry economically attractive to more landowners. It appears, therefore, that the initiative for developing forestry machines must continue to come, as in the past, from those who want better forestry practice in the United States.

The ideal approach would seem to be a plan whereby the professional foresters and engineers would get together to search out and appraise the bottlenecks that are standing in the way of good forest practice. This would help to prepare both groups for the attack on the problem of what to do about the bottlenecks after they are discovered. Before reaching the point where real progress will be made, the engineers need to learn the limitations placed by the forester on the use of equipment, and foresters need a better appreciation of what the engineers can do with machines.

Equipment designers have developed machines for some jobs without full knowledge of the conditions under which the work must be done. Thus we often hear the foresters com-

(*Continued on page 732*)

How ENGINEERS *Can Promote* INTERNATIONAL UNDERSTANDING

By ROBERT M. GATES

REPRESENTATIVE OF THE ENGINEERS JOINT COUNCIL ON THE UNITED STATES NATIONAL COMMISSION FOR UNESCO. PAST PRESIDENT, ASME

THE overshadowing problem of the United Nations is the attainment and maintenance of a just and durable peace. The major task of each of its agencies is its possible contribution to that end. This is also the main concern of the American people. It enters into the thinking and activities of many voluntary groups also that are organized for other purposes—churches, professional associations, business groups, and others. We believe other peoples around the world have the same concern—whatever may be the attitudes and motives of their present rulers.

This memorandum suggests use of a fairly open road that may be used for the promotion, in all countries, of the mutual understanding that is essential to the winning of world peace.

BARRIERS TO MUTUAL UNDERSTANDING

The underlying obstacle to progress toward world peace is in the barriers raised against mutual understanding. Neighbors, even members of the same family, have disputes and conflicts. If they have free intercourse and are working together for some common purposes, however, disputes are less likely to become serious conflicts and may be resolved peacefully. Practicable ways and means for reconciling or adjusting disputes are found where there are mutual understanding and mutual recognition of common interests. All peoples of the world, whatever the aims of groups among them, even governing groups, have some fundamental common interests that are recognized when barriers to mutual understanding are removed.

Language. One barrier is that of language. In our "Tower of Babel," where we are now brought close together by new mechanical means of transportation and communication, our freedom of intercourse is limited by the variety of languages we have developed in centuries of isolation. Yet this barrier is gradually breaking down. Science, engineering, and technology are contributing to this breakdown. They have to do with materials and processes and laws which are not affected by national or racial or linguistic boundaries; and scientists, engineers, and technicians in all countries have a common understanding of the meaning of the terms peculiar to their arts. Most of them also have had to learn more than one language in the pursuit of their profession.

Prevention of Intercourse. Another barrier to mutual understanding is raised by political, ideological, and military groups whose aims may be frustrated by free intercourse. There are such groups in nearly every nation. They may hold up the specter of fear, or the hope of domination, or the precarious comfort of smug isolation, or other emotional considerations as motives justifying nonintercourse policies and practices. It is true that there is reason for the concern of many peoples for their national security. The confused state of world policies and the too prevalent use of aggression in international relations have created tensions—fear and suspicion that have some foundation and justify protective measures.

Yet we must recognize that this tension must sooner or later be relaxed, and we need to explore all possible means of relaxing it, if we are to get a just and durable peace in this neighborhood of nations. The people themselves even in the nations apparently most aggressive probably want peace rather than war. They want to carry on their peaceful occupations and their friendly intercourse with other peoples—exchanging goods and services and information freely for mutual benefit. That is the way of human progress.

Most peoples are aware that no nation has a monopoly of the science, engineering, and technology that they can use to raise their standard of living. We may take advantage of this awareness, and the still keener awareness of those who are trained in these arts, to do a notable service to all peoples. The most exclusive nations, with the most rigid censorship, admit or even seek the technical publications of foreign authorship.

Economic Inequalities. A third barrier to mutual understanding is the inequality of living conditions and of opportunities to improve them among the peoples of the world. At one extreme are millions, indeed hundreds of millions, of people who have, and perhaps always have had, incredibly poor living conditions, and who have no resources available or else no knowledge of how to use them for improvement of their way of life. At the other extreme are people with a high and rising standard of living, widely shared, and with the resources and the know-how to improve it from generation to generation. We have not been responsible for the low state of these underprivileged peoples; indeed we have made substantial efforts in some areas to improve it, and to show ways to improve it. Between the two extremes there are various gradations; but at least half the world is restless in its poverty and misery, as it comes to realize that such is not the common lot of mankind.

Modern means of transportation and communication, in so far as they have brought the less privileged peoples into contact with the more privileged, have contributed somewhat to mutual understanding, but perhaps more to misunderstanding on the part of the less privileged, since they have been subject to a flood of propaganda from within and without, as the world turmoil has reached them and raised factions among them.

The political and economic aims and practices of our own nation, even as we have tried to be helpful, are daily misrepresented, insidiously or openly, in Latin America, Europe, Africa, and Asia. Our economic strength and potential military strength have been demonstrated. Frequently, in history, even recent history, nations having superiority over their neighbors in these respects have been led to use that superiority

for aggresive purposes. Many peoples have learned this by bitter experience. Suspicion of such a purpose is easily aroused against us where there is no understanding of our real ways of life and the public opinion underlying our national policies. Nor does counterpropaganda through political or military channels remove this suspicion; it is discounted as mere propaganda for selfish purposes.

Yet, gradually, the things we and other more fortunate peoples do to help those who need our help are meeting appreciative response. Notably is this true among those persons in these countries who have had most contact with our ways of life and with the translation of scientific advances into human welfare. This appreciation can percolate from one level to another as people see how they can come to share these advances, in their own ways, through the technical information and other technical aid we offer them. Thus another barrier to mutual understanding may be removed.

TECHNICAL LITERATURE WELCOME

In many foreign countries our publications in such fields as religion, philosophy, economics, sociology, government, and even general information are not welcome because their contents, as a whole or in part, may seem subversive of prevailing ideologies or customs or traditions. Or they may contain facts or opinions regarding the country that seem derogatory in some respect. Various obstacles to circulation of our newspapers, periodicals, and books are imposed in different countries. Yet the literature that scientists, engineers, and technicians are most eager to get encounters few such obstacles.

In our scientific, engineering, and technical publications little or no political propaganda or other material is found that would be objectionable to foreign governments. In our engineering publications, for example, foreign technicians see mainly how in a multitude of ways American engineers are devoting themselves to improvement of plants, processes, and practices for production and distribution of the goods and services people want—not our people only but people in other lands. This information is broadcast for the benefit of engineers—and of people—everywhere.

For example, I note in a single issue of this publication: Descriptions of new automatic machines, apparatus for communications equipment, recent progress in railway mechanical engineering (not only in America), equipment for gas-turbine generators, underground power plants, electronic printing presses, jet engines, Diesel engines, a photomicrometer, new capacity for aluminum and steel production, new aircraft safety devices, and much other such information as is useful to engineers everywhere. It contains also reports of meetings that show what American engineers talk about when they get together. And the well-illustrated advertising pages afford a further guide to the mechanical advances being made in the use of resources to meet peacetime wants. Such literature is an antidote to propaganda that the American people are occupied with plans for political, economic, or military aggression. It teems with information of things other peoples can do, with proper technical aid, to help themselves to better living.

The five great American engineering societies, which publish such periodicals, reports, and other literature, have a total of some 14,000 members and subscribers in foreign countries—more than a hundred countries—and other affiliations with engineering groups and institutions abroad. It is notable, for example, that these subscribers include over 650 in Soviet Russia, over 600 in India, over 200 in China, over 1100 in South America, nearly 500 in Africa. This membership is a nucleus, though only a nucleus, of the great body of engineers and technicians around the world who speak the same language of science, have similar approaches to practical problems, and are least responsive to emotional propaganda that transgresses reality. They are concerned most with how best to do work that needs to be done in the arts of peace—work that has no national boundaries.

Here we have a wide field open for a use of the traditionally international character of technology, and the normally mutual understanding among technically trained people that will serve the interests of all concerned.

We can use it to clarify and emphasize the community of interest among all peoples—to mitigate the divisive effect of propaganda that stirs fears and hates—to build up a core of co-operative will within groups whose aid will be required to make co-operation among the nations practically effective when present tensions are relaxed and the obstacles to international intercourse are removed.

PROCEDURAL SUGGESTIONS

What immediate steps can engineering societies take to promote better international understanding? A few suggestions follow:

1 We can and do find out (*a*) where engineering and technical publications now circulate abroad, (*b*) where they are available in depositories and libraries, (*c*) where there are training institutions for engineers and technicians, (*d*) where foreign students who have had such training in our own institutions are now located. This information may be obtained from UN organizations, from consular agencies, from engineering societies and their affiliates, from publishers of technical books and periodicals, and from other sources. This involves a considerable amount, but not a prolonged period, of integrated research.

2 Ways and means may be devised to use this information to provide a wide distribution of technical literature—periodicals, reports, and books—where there is reasonable assurance that it will be used. Some suggestions of kinds of distribution include the following:

(*a*) Supplies of such materials to agencies now engaged in distribution of relief, for free distribution in accordance with reported need within the reach of such agencies.

(*b*) Supplies to present foreign depositories for sale at cost plus commission for distribution where such arrangements can be made; in the case of technical books, arrangements should not be destructive of present commercial practices. And the current coupon system may be used for payment.

(*c*) Gifts to libraries and training institutions, supplementing their present purchases, if any, for their use within the institutions or even some distribution outside. In many of these countries, the direct or indirect impact of war stopped entirely the flow of such literature from abroad—even shut off local publication or destroyed the accumulation of years.

(*d*) Extension of some type of membership in our professional technical societies which will assure receipt of reports and other information.

(*e*) Co-operation of organized foreign technical groups in whatever ways may promote effective distribution and use of material meeting needs in their respective areas.

3 To meet the cost of such an undertaking a variety of suggestions occur, including the following:

(*a*) Appropriations by engineering societies, and perhaps advertisers in their publications, toward the cost of distribution of these publications.

(*b*) Concessions by publishers of technical books—perhaps the issue of special low-cost editions.

(*c*) Appropriations by a foundation to finance the whole undertaking, on the basis of nonprofit participation of engineering societies and publishers.

(*d*) U. S. Government, or a UN agency (for instance, UNESCO) might finance the undertaking, or at least aid in some phases of the project.

(*e*) Universities and colleges, as publishers or otherwise, might aid in furnishing useful material.

(*f*) For some countries the problem of translation would need to be taken up if the need justified it, but foreign professional engineers generally have learned English as well as their native language.

Engineers share the common concern for the promotion of better international understanding and the achievement of a just and durable peace. Their training and experience give them more than ordinary concern with practical approaches to the problem. Their ways of service must take into account human as well as technical realities.

The procedures which have been suggested should not be approached in the spirit of merely charitable giving, but with the conviction that peace and mutual understanding are desired by all peoples and benefit all peoples. No matter how desperate their condition may be, people desire to help themselves. It is our task to help them overcome the obstacles that stand in the way of helping themselves. In so far as the obstacles are economic, as, for example, unfavorable exchange rates, aid can be extended without damage to initiative, incentive, or self-respect, if the proposed program is administered intelligently. Only by such intelligent administration can engineers work effectively for peace and better international understanding for the benefit of themselves and all peoples everywhere.

Machines and Forestry

(*Continued from page 729*)

plain that the engineers and their machines have disrupted silvicultural management while performing one of the functions of such management. Road-builders' tractors have been responsible for fires that destroyed the timber that the road was being built to protect.

Thus searching out the forestry jobs that should be mechanized should be a joint effort between foresters who know what should be done and the precautions necessary in doing it, and engineers who know what machines can do. No better combination for such a job could be developed than representatives designated by and from among the members of the professional forestry and engineering societies. The present joint SAF-ASME committees on forest protection are a step in this direction. What further steps should be taken?

Another question is where should the attack on the problem of mechanizing forestry be made; at the national level or locally? The author would say at both levels concurrently.

Aluminum Seamless Tubing

(*Continued from page 726*)

opposite angle to the tube. As the tube is put through this machine, it passes over the staggered-roll faces in a spiral rotating manner. The rotating forward motion works all the integral parts of the tube by both alternate longitudinal bending of the tube and a rotating deformation of the cylindrical wall, thus equalizing internal strains imparted by drawing and heat-treating.

From this operation the tube emerges both straight and round. As may be expected, this process also cold-works the metal and may increase the tube diameter. This change, as in stretching, may be used to advantage in bringing tubing slightly low in dimensions back within allowable tolerance, providing of course that the physical properties desired are not impaired. Again, as in the stretching process, allowance must be made in the drawing operation to meet this condition.

CONCLUSION

Aside from the heat-treating operation, which is used on strong alloy tubing only, the operations described are used in some varied sequence on nearly all alloys, tempers, and sizes of tubes produced. These sequences of operation, when followed by sawing to length, a final cleaning, aging in the case of some strong alloys, a rigid inspection and packing, complete the fabricating process used for aluminum seamless tubing.

Extraction and Refining of Shale Oil

(*Continued from page 711*)

enough margin to provide for income taxes and return on investment. Because opinions differ widely as to what the rate of return should be, no figure is quoted as an estimated selling price. However, as an illustration, it is pointed out that if the market dictated a selling price of $2 a barrel, the return on the initial investment, based on the $1.50 cost figure, would be approximately 6 per cent a year after income taxes.

The refining cost of shale oil probably will be somewhat higher than for most petroleums since shale oil is of a comparatively low refining quality. However, the results achieved in experimental shale-oil-refining operations have been encouraging, and it seems reasonable to expect that continued study and experimentation will produce results that will improve the economics of converting crude shale oil to refined liquid fuels. It may be possible to develop a refining method that would use the special properties of shale oil to advantage and therefore be better suited for shale-oil processing than the petroleum refining processes of today. Furthermore, the by-products of a shale-oil industry may have enough value to favor the over-all economics of the industry appreciably.

Research Laboratory

A NEW research laboratory, said to be the world's largest, devoted to the development of safety equipment for all industries was dedicated recently in Pittsburgh, Pa., by the Mine Safety Appliances Company.

Since 1914 the company's activities have expanded from mining into all branches of industry on a world-wide scale.

Safety equipment and instruments for use in such relatively new fields as air pollution and atomic energy are among the projects planned in the laboratory. There will also be continuing research to improve existing safety devices and rescue apparatus.

Virtually every branch of science and engineering is utilized at the laboratory for developing protective equipment and instruments. The laboratory is staffed by chemists, physicists, electrical engineers, and other scientists.

The four-story laboratory building includes many types of research instruments and equipment such as high-altitude chambers; dust, fume, and gas chambers; a wind tunnel; and an electron microscope that permits study of dusts and other substances at a magnification up to 100,000 times.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Atomic Information Controls

ACCORDING to a recent address given by Henry D. Smyth of the Atomic Energy Commission in Washington, D. C., the Commission recognizes that a dilemma exists in connection with atomic-energy information.

On the one hand, he said, rapid progress in basic science requires free interchange of information. Modern military technology depends upon basic science. Therefore, to achieve maximum military strength, there must be free interchange of information.

On the other hand, American military technology must, in so far as possible, surpass that of our potential enemies. New weapons developments on which millions of dollars and the time of thousands of men have been spent must not be given away. Yet these developments may depend upon discoveries in science. Therefore there must be complete secrecy in both science and technology.

To further complicate this dilemma, he pointed out, there must be taken into account all the evil effects of secrecy outside the fields of science and technology. In particular, it must be remembered that the whole American system of democratic government assumes that the people should be kept informed—that billions of dollars of the taxpayer's money should not be spent without telling him how or why. Yet the American people certainly do not want either our war plans or the details of our armaments to be published. They know that 150 million people cannot keep a secret and that a certain amount of secrecy is important, even in a democracy.

A clear solution to this dilemma would be possible only if it were known exactly when the United States might have to defend itself in another war. If it were to be next year, there should be virtually complete secrecy; if it were certain that there would be no war for 30 years, virtually all secrecy should be abandoned.

In view of the current international situation, Commissioner Smyth stated, a middle course is evidently necessary—a course which will make it possible for the United States to defend itself with vigor and success if it is attacked within the next few years, and yet a course that can be followed for many years without seriously weakening our democracy or our science.

To make the most effective compromise, the Commission has laid down the following three fundamental principles as guides: (1) Weapons information, including design, production, and stockpiles, should be kept secret; (2) basic science should be free except where it is directly related to weapons; and (3) until international control is attained, there shall be no information exchanged with other nations on the use of atomic energy for industrial purposes.

In addition to these three basic areas, there is also a twilight zone of information that does not fall automatically into these categories, he said. In attempting to judge such information, the Commission uses a simple criterion: It asks the question, "Will the release of this information help the United States atomic-energy program more than it will help the atomic-energy program of a potential enemy?

Although this is a simple criterion, it is very difficult to apply. In attempting to apply it, the Commission assumes, perhaps rightly, perhaps wrongly, that it makes a great deal of difference who is giving out information.

Essentially, the Commissioner said, there are six categories of people who might write or say something about atomic energy that would help a potential enemy: (*a*) Full-time employees of the Atomic Energy Commission or its contractors with access to classified data; (*b*) scientists who have had access to classified data or still do on a part-time basis; (*c*) scientists whose work is supported by the Atomic Energy Commission but without access to classified data; (*d*) entirely independent research workers who have never had access to classified work but who may turn up ideas of military value; (*e*) writers, lecturers, editors, columnists, or public officials who have had some access to classified data; and (*f*) similar men who have had no official access but are shrewd enough to pick up significant information by interviews with informed people or even by guessing from published materials.

There are three areas in which these people may happen to talk or write: Detailed technical articles of limited scope; general articles of professional or popular level discussing the work of the AEC or related topics, and general articles or speeches,

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

primarily concerned with the political, moral, or military aspects of the work of the AEC.

Thus there are 18 categories of articles and speeches which concern the Atomic Energy Commission in one way or another. Since there are practically no articles even vaguely related to atomic energy that do not fall into one of these categories, the Commission must rely upon common sense to limit its activities.

If detailed technical articles are written by authors in category (*a*) the AEC declassification system can be employed satisfactorily. This applies almost equally well to authors in category (*b*) except that the Commission must rely upon the voluntary co-operation of the authors or of the editors of technical journals who submit for clearance those papers about which there may be some doubt. This intervention by editors is also helpful to the Commission with articles prepared by the third category of authors.

The number of authors of technical papers in category (*d*) is small. Here the Commission must depend entirely upon the good sense of the authors and on the co-operation of editors.

Authors in categories (*e*) and (*f*) are not likely to write technical articles. If they do write such articles and publish them in journals whose editors are not alert, the Commission has no formal way of obtaining them for review.

The Commission believes that the nontechnical parts of general articles, written by authors who may be connected with the atomic-energy project but who are not full-time employees of the Commission or its contractors and whose present connection with the project is not on a policy level, constitute an area where interference would clearly be unjustified—except with the writings of full-time project people for administrative reasons.

According to Commissioner Smyth, the Commission believes that public discussion of political or moral questions arising from development of atomic or hydrogen bombs is vital to wise decisions in a democracy. The Commission neither has nor desires to have any authority to interfere with public discussion of such questions.

The Commission follows the policy of disregarding almost entirely the speeches and writings of those who have had no access to classified information. This is done to restrict the Commission activities and as a security safeguard.

By specifying what should be taken out of speculative articles and talks, classified information would be underscored and revealed to the authors who have had no previous access to classified information and who presumably are not cleared to receive it. As long as the Commission makes no comment on speculations of people who do not have access to restricted data, a competitor will not have help from an official source in his problem of differentiating fact from fancy.

Atomic-Energy Reports

THIRTY-ONE American libraries in all parts of the country have been named as official depositories for complete sets of atomic-energy declassified and unclassified research reports, the Atomic Energy Commission announced recently.

At the present time there are approximately 3500 reports in a full set and about 1500 new reports are issued every year. In addition to providing each depository library with a full set of documents the AEC will furnish a catalog card index to assist the public to use the documents effectively.

In agreeing to be named as a depository, each library undertakes to provide access to the atomic-energy reports, reference service with regard to them, and photocopies to users in accordance with its established prices for such services.

At the request of the AEC the list of depository libraries was suggested by the Board on Resources of American Libraries of the American Library Association. The libraries are located near major centers of scientific and industrial activity.

Pump-Turbine Unit

REVIVAL of interest in the old idea of pumped storage hydroelectric power was stimulated by Allis-Chalmers engineers recently when they demonstrated their newly designed pump-turbine unit. The combination unit—for off-peak pumping from a low-level to a high-level water reservoir and peak-period power generation with reverse flow—would make this method of storing water power economically feasible for the first time, according to Allis-Chalmers officials.

Elimination of the need for additional pumping equipment is the major advantage in the new unit. The pump-turbine is a single runner enclosed in a casing with a stay ring and movable wicket gates. Rotated in one direction it is a centrifugal pump; reversed, it functions as a hydraulic turbine through which water returns from the storage reservoir to generate power at periods of greatest demand.

A test-model demonstration showed promising possibilities of the pump-turbine supplying the answer to a utility's problem of utilizing equipment efficiently for 24 hours a day. This is accomplished by supplying power for the pumping phase through use of generating equipment which would normally be idle in the periods of off-peak demand on the system. Only the fact that power can be sold at a premium price in peak-load periods justifies the pumped storage procedure, since the higher sale price must offset the cost of moving the water to the higher reservoir and back.

For example, say a unit is required to supply 5000 kw at 163.6 rpm for an 8-hr period; and there is a static head of 80

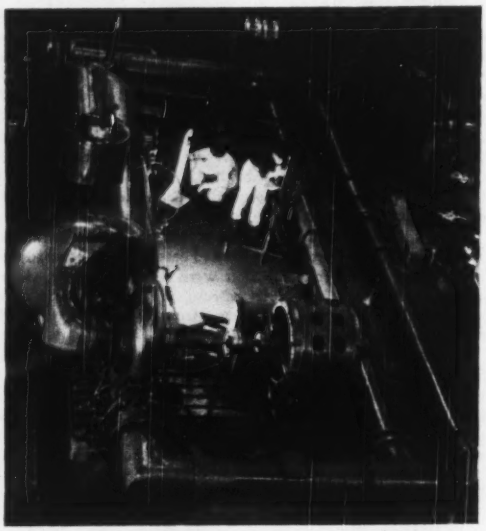

FIG. 1 TEST LOOP FOR THE ALLIS-CHALMERS PUMPED STORAGE HYDROELECTRIC POWER PROJECT INCLUDES TWO IDENTICAL PUMP-TURBINE UNITS, ONE FOR TESTING AS A PUMP AND ONE FOR TESTING AS A TURBINE IN THE SAME CIRCUIT

ft between the full-storage pond and the lower-level suction pool drawn to its lowest level. With an average of 9700 bhp required, pumping for 8.53 hr would consume 82,700 hp-hr, or 63,600 kwhr at 1.0 power factor. At 4 mills per kwhr, the total cost for pumping would be $254.40. Power generated would total 40,800 kwhr, and if this could be sold for 1.25 cents per kwhr in peak-load periods, it would be worth $510—a ratio of return of about 200 per cent.

The test loop includes two identical pump-turbine models, one being tested as a pump and the other as a turbine in the same circuit. In the test procedure gates of the pump and turbine are set at the same opening, characteristics of each unit being determined from this gate setting. The process is continued for different gates until enough data are obtained to draw a family of pump-turbine characteristics with gate settings as a parameter. Thus reliance is placed on the wicket gates as well as on compromise design of the runner, to improve the fit between the pump-turbine characteristics and the characteristics of the external system.

Pumped storage hydroelectric plants will require electrical equipment of the same general nature as is now used in generating stations or pumping plants. It is indicated that special requirements of the application can be met without excessive development or unreasonable cost. Although the pumped storage plant will generally require more electrical equipment than a comparable generating plant, some features, such as voltage regulation and pilot excitation, usually considered necessary in a generating plant might actually be eliminated in the pumped storage plant.

Steam Wind Tunnel

IN order to reduce the cost of supersonic wind tunnels and to make them more widely available, an investigation of the possibilities of using steam instead of air was begun at Pratt Institute, Brooklyn, N. Y., early this year, according to James R. Randolph, Mem. ASME, and a lecturer at Pratt. Three senior students, Daniel Weinstein, Sidney Weinberger, and William Hoffinger, working under Mr. Randolph's supervision, built a model wind tunnel adapted to the Institute's steam supply which develops speeds of 1500 mph. A model with a higher speed is contemplated, and there will be theoretical studies of designs for still bigger and better ones, Mr. Randolph stated.

This Pratt model takes wet steam at 115 psia, throttles it to 5 psia, which makes it superheated, expands it in a nozzle to 1.2 psia and delivers it to the condenser at 4 psia. A Mach number of 1.56 is obtained

If this same steam were superheated to 1000 F, Mr. Randolph pointed out, a Mach number of more than 8 could be obtained (the Mach number in the New Wright Aeronautical Corporation ramjet test chamber is less than 4) and the pressure recovery after the test section is passed is almost enough to permit the condenser to be eliminated.

The upper limit of commercial practice with superheated steam is about 1000 F. In the Pratt laboratory where only wet steam is available the superheater would be a part of the wind-tunnel installation. An electric superheater would be the simplest and cheapest to build, consisting merely of some heating coils inside a pipe, but it would be expensive to operate. Most of the operating cost could be saved by using a regenerative superheater, because the pressure recovery raises the temperature of the exhaust nearly to the temperature the steam had before entering the nozzle. Only the unavoidable temperature drop through the walls of the heat-exchanger tubes prevents the complete recovery of this heat.

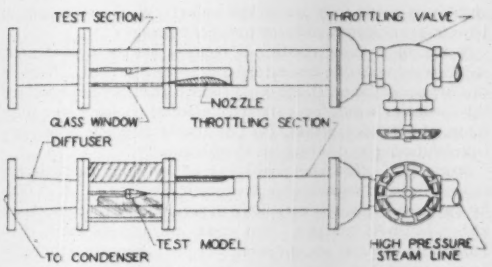

FIG. 2 DIAGRAMMATIC SKETCH OF PRATT INSTITUTE STEAM WIND TUNNEL

The Pratt model was built out of pipe fittings and small pieces of steel left over from larger projects. The cost for materials was less than $100. Its test section is only 2 × 2.5 in. (limited by the amount of steam available) but even this small size can be useful in a college.

The Mach 3 model, using superheated steam, also would need a standard commercial superheater, though much larger in proportion to the load because the temperature difference is so much smaller than in commercial practice. This would have to be built into a tank capable of withstanding an outside pressure of 15 psia, and be completely insulated. It would add considerably to the cost, but would be much less expensive than equivalent compressors for air.

For a Mach number of 4 a pressure of more than 200 psia would be necessary, but such pressures are common in commercial steam plants, Mr. Randolph said. The difficulty here is the necessity for superheating to more than 1400 F. Superheater tubes become unsafe at such high temperatures, therefore the last 200 deg at least would have to be done by electrical means.

He pointed out that steam wind tunnels offer an attractive extra market for commercial plants selling high-pressure heating steam. They can afford a rate that makes them profitable as customers. Their demands for steam are normally confined to daylight hours. No great hardship is involved in cutting them off in cold weather when the heating load is large. They are practical wherever colleges are located within piping distance of large steam plants.

Steam has its limitations, of course, because of its thermodynamic characteristics. Its minimum temperature is tied to the pressure. It cannot be less than 212 F at atmospheric pressure or 101 F at a pressure of 1 psi. These high temperatures are not merely unpleasant—they also increase the velocity of sound, and hence the actual steam velocity for a given Mach number. The velocity of sound in steam at 1 psia is 1433 fps, while air under the same conditions can be expanded to —60 F where its velocity of sound is 980.9. For a given Mach number the kinetic energies are proportional to the squares of these velocities, so that the steam contains more than twice as much energy per pound, and because it is going faster more of it goes through a square foot of area in the same length of time.

But these higher operating costs are in many cases more than offset by the greatly reduced first cost.

High supersonic speeds necessarily mean high altitudes because the resistance caused by shock waves is proportional to the pressure in the surrounding air. Hence the development of high Mach number wind tunnels has also been a development of external low-pressure wind tunnels. But if the pressure of air in the test section is reduced to that found at an altitude of 80,000 ft, the pressure recovery, even at Mach number 4, is not

enough to get the air out of the tunnel. Ejectors or suction blowers are needed in addition to the compressors.

Steam under these conditions requires merely a condenser. At Pratt an available laboratory condenser was used. Even in the largest and finest steam wind tunnels that can be conceived the condenser would be a standard piece of commercial equipment, Mr. Randolph said, but not abused as much as in commercial steam plants which use them regularly.

Steam also offers the possibility of building much larger supersonic wind tunnels than are practical with air. A 15,000-hp compressor plant is very large in present-day air-compressor and gas-turbine practice. But steam turbines of more than 100,000 hp capacity are commonplace, and there are frequently four or more of them in a single power plant.

Supersonic Test Missile

THE Army Ordnance Department successfully fired an "ORDCIT" test missile approximately 50 miles at White Sands Proving Ground, New Mexico, recently.

The test flight established no new records for altitude or range, but the missile is the first American designed and built surface-to-surface supersonic missile to be remotely guided from the ground, Ordance research officials said.

Not a weapon, the test missile is a vehicle designed to test components under development which may or may not be used in some future weapon application. Purpose of the flight was to test integrated rocket components and systems about which advanced knowledge under flight conditions is badly needed. One important phase of this program is the study of remote control of supersonic missiles—their guidance from the ground while they are in flight.

The vehicle-missile tested incorporates all the latest improvements resulting from the research in components at the Jet Propulsion Laboratory of the California Institute of Technology in 1947. Specifically, the objective of this test was the evaluation of a new lightweight type of propulsion system and the determination of its effect, if any, under actual flight conditions, on the control and guidance components.

The ORDCIT is 45 ft long and $2^1/_2$ ft in diam, and has a cylindrical contour slimmer than the V2. Its motor operates on aniline and nitric acid, the former as the fuel and the latter as the oxidizer. Like other large guided missiles, it is launched vertically without the use of booster rockets, and angles over toward its surface target after it has gained altitude.

The Douglas Aircraft Company has constructed the ORDCIT missiles under contract with the Ordnance Department and in accordance with specifications prepared by the Jet Propulsion Laboratory of the California Institute of Technology. The initials of the Institute added to the abbreviation of Ordnance made the name: ORDCIT.

Ramjet-Engine Testing

THE U. S. Navy has announced that tests of large-scale ramjet engines at simulated altitudes of 100,000 ft and at four times the speed of sound are being conducted in a newly completed test chamber at the Ordnance Aerophysics Laboratory, Daingerfield, Texas, according to the *Technical Data Digest* for July 1, 1950.

The laboratory is operated for the Navy Bureau of Ordnance by the Consolidated Vultee Aircraft Corporation, under the technical direction of the Johns Hopkins University Applied Physics Laboratory.

The new chamber makes possible for the first time high-altitude tests with full-scale ramjet engines as large as 48 in. in diam.

Since most missiles are destroyed when flight-tested, this kind of laboratory research prior to free-flight trials saves both time and money.

The cylindrical test chamber is 10 ft in diam and 125 ft in length, with a door in its side 30 ft long, through which ramjet engines are installed for tests. A high-pressure air supply, coupled with a vacuum system for simulating high altitudes, enables engineers to conduct tests throughout the normal operating range of ramjet engines. The vacuum system combines steam-jet ejectors with turboblowers to obtain maximum capacity from a steam supply of 270,000 lb per hr at a pressure of 400 psi. By way of comparison, this quantity of steam would supply electricity for a city of 100,000 persons. A cooling system provides 30,000 gal of water per min to the barometric condenser between the ejectors and blowers and to the ramjet exhaust cooling chamber.

In the past, Navy research facilities have been unable to test large ramjet engines up to simulated altitudes of 20,000 ft. Smaller ramjet engines, with diameters of 6 in. or less, however, have been successfully tested for nearly two years in a high-altitude chamber at the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md.

For five years the Ordnance Aerophysics Laboratory has played an important role in the nation's guided-missile program. It has been operating three sea-level ramjet test chambers and a supersonic wind tunnel capable of speeds up to 1800 mph through a rectangular test section measuring 19 × 27.5 in. The largest supersonic ramjet engine ever flown resulted from research and development conducted at the Ordnance Aerophysics Laboratory by the various organizations associated with the Bumblebee missile project.

Magnesium Airplane

AN all-magnesium-alloy airplane is now in the planning stage by the Air Force, the July 1, 1950, issue of the *Technical Data Digest* reveals. According to engineers in the Air Materiel Command Aircraft Laboratory, the construction of such a plane is considered practical because of the successful application of magnesium to structural components, especially in tests on the wings of the Lockheed F-80 fighter. These wings, made entirely of magnesium-zirconium alloy, employ a thick, unreinforced skin as surface covering in place of the conventional stringer-reinforced thin-skin type of construction.

The new type of wing has already undergone extensive static tests and has been test-flown on the F-80 for a total of 120 hr without showing any adverse structural characteristics.

Although its skin is more than seven times as thick as that of the conventional wing, the magnesium wing is believed better because very few internal reinforcements (stringers and chordwise formers) are needed to prevent buckling at high loads. This leaves considerably more space for larger fuel tanks. As a result, the improved wing and greater fuel load increase the range of the F-80 by approximately 30 per cent (based on the wing alone).

Only about 35 per cent of the detailed parts and fastenings used in conventional wing construction are contained in the new magnesium wing. One example of its simple construction is the fuel door. This is now simply a heavy plate, completely free of internal reinforcements. The conventional fuel door was made of relatively thin skin reinforced by stiffeners.

Both magnesium alloy and aluminum alloy have been used in the thick-skin type of construction and both were found satisfactory. However, in case of emergency, aluminum would

probably be harder to procure than magnesium. Aluminum is refined from the mineral bauxite while magnesium can be obtained economically from ocean water.

During World War II, magnesium alloys had not been developed to the point where they were suitable for aircraft construction. The main drawbacks were low impact strength plus the fact that the alloys were subject to fatigue cracks and to corrosion under tropical marine conditions. Since then, the physical properties of magnesium alloys have been improved and satisfactory protective coatings developed.

Prior to the use of magnesium in the experimental F-80, the alloy, coated with a zinc-chromate primer and painted with a suitable lacquer, varnish, or enamel, was used in the construction of the North American T-6 trainer. Protected by the coating, T-6 components made of magnesium were flown under severe climatic conditions without showing any bad effects.

Packaging Test Chamber

A SOLUTION to the special problems of air transportation posed by temperature, altitude, and vibration is being sought by the Packaging Branch of the Materials Laboratory at Air Materiel Command Headquarters, according to the June, 1950, issue of the CADO *Technical Data Digest*. A new test chamber recently installed at the laboratory is helping to provide the answers by simulating flight conditions and providing actual statistics on what happens to a package when it is transported by air.

The chamber, looking like a large walking vault, can be changed from conditions at sea level to those encountered at an altitude of 50,000 ft in three minutes, and can have its temperature lowered 100 deg in that same period of time. The operating temperature range of the test chamber extends from 165 F to —65 F.

A vibration table, specially designed for installation in the floor of the chamber, carries loads up to 1000 lb and has cycles of 600 to 3600 vibrations per min. The AMC chamber is said to be the first to combine all three elements of temperature, altitude, and vibration.

AMC is particularly interested in designing adequate packaging for "dangerous" items which it must transport for itself or for other branches of the Armed Services. The long list includes such troublemakers as acetone, sulphuric and nitric acid, naphthas, varnishes, ethers, cleaning fluids, nitroglycerin, ammunition, and certain photographic materials.

The packaging for shipment on the ground is controlled by regulations set up by the Interstate Commerce Commission, but this same packaging is not always adequate for transportation by air. The rarefied atmosphere and extreme cold of high altitude can cause definite reactions which increase the danger of already dangerous items during shipment.

The Packaging Branch studies lists of "dangerous-to-ship" items prepared by technical committees of Ordnance, Chemical Warfare, and other groups within the Armed Services to determine the special characteristics of each product and its reaction to temperature, altitude, and vibration. Special containers and special cushioning are prescribed to meet the specific needs of each item. Outer packages are generally made of metal, fiber, and wood, while cushioning may be cellulose fiber, sponge rubber, fiberglas, or curled hair and latex. Insulation is provided by cork, asbestos, or any other material that will prevent the transfer of heat and cold to the contents of the package. In many cases air space provides the most suitable insulation.

The tests conducted by the Packaging Branch have resulted in the development of some distinctive containers. For example, hydrofluoric acid will burn the skin, but for surface shipment it is reasonably safe to put it into ordinary glass bottles packed in divided fiberboard cartons. In flight, ordinary glass bottles are too much of a risk. The Packaging Branch now specifies a pliable bottle of polyethylene which can be tossed across a room as safely as a rubber ball. Polyethylene is also specified for a special container to hold battery electrolyte for spare aircraft batteries. This makes an acceptable-for-air-shipment package.

An ordinary mercury-filled thermometer hardly sounds dangerous—but mercury running around loose can eat a hundred holes in the aluminum of an airplane during a comparatively short flight. The branch has solved this problem by specifying that thermometers and other mercury-filled items will be packed in outer containers of metal which will retain the mercury should the items break.

When a new package is designed, the packaged item is placed in the test chamber and taken on simulated flights. If the package is unable to survive the vibrations of the aircraft, or the extremes of altitude and temperature, the engineers know they need to revise their packaging requirements.

Fire extinguishers and safety devices built into the test chamber provide protection in case any dangerous items catch fire or explode during the test.

A few items are so extremely dangerous in flight that they will be carried only in those rare instances when the commanding officer determines that the nature of the emergency outweighs the risk involved. For all other items, if a safe package can be devised, Packaging Branch engineers will prove its safety in the "simulated-flight" test chamber long before a pilot is ever asked to carry it on an actual run.

Sound Progress

HIGH-INTENSITY sound can cause a fearsome agitation in liquids, but few industrial jobs have yet been developed, despite the fact that sound will wash clothes, "age" whisky, and perform other tasks on a laboratory scale, according to the July, 1950, issue of the *Industrial Bulletin* of Arthur D. Little, Inc. Fairly efficient sirens have been used to generate sound in gases and thus free them from dust and fogs, but, the article states, until recently it has been difficult to generate enough sound in liquids to do these jobs on a reasonable scale. Recently, however, mechanical sound generators have been built to full scale for various potential industrial applications, and a new ceramic material, barium titanate, gives real promise of advancing the technique.

Barium titanate is intended as a replacement for the piezoelectric crystals, such as quartz, which have the property of expanding and contracting as an alternating electric potential is applied to them and, by this vibration, generating sound waves. Crystal plates of natural and synthetic quartz and of several other materials have been used, but the plates are small in size, expensive, and fragile. Barium titanate is not a single crystal, but a ceramic material which can be molded to any shape and made into large sizes. It also can convert a large amount of power per unit area into sound, and may be used in the same frequency range as piezoelectric devices.

After manufacture, the barium-titanate element must be "prepolarized" by an electric treatment somewhat analogous to magnetization of a permanent magnet. Following this treatment, it has excellent piezoelectric properties as long as it is not heated much above the boiling point of water. The material can be made into bowl form to focus the sound waves at a point or into a cylinder to focus them on liquids passing through the cylinder. Shapes several inches in diameter have been made.

Several of these can be combined to cover a virtually unlimited area with sound-generating elements. The Brush Development Company is now producing ready-made laboratory and pilot-plant generators based on barium titanate.

Much of the efficacy of sound in speeding chemical and physical changes within liquids is due to cavitation, the formation and violent collapse of tiny vacuoles or bubbles as the sound wave passes over. This involves forces up to several hundred thousand times gravity. This small-scale tumult can mix materials so intimately that they react far more quickly than they otherwise would. It can also destroy the surface of the sound-generating equipment unless proper precautions are taken.

The fact that considerable skill and experience are needed for sonic research has tended to limit its investigation by the industries which might use sound and to keep the research in the hands of specialists with limited funds and limited familiarity with possible applications in industry. Several companies now offer sound-generating equipment for laboratories and pilot plants. With this equipment, possible users can determine whether a problem is suited to ultrasonic techniques and whether a custom-built production unit or a large-scale trial unit is justified.

Office Layout

LENGTH and width are the dimensions traditionally considered in office layout. Confronted with the need for increased facilities, management normally rents more space or erects its own buildings. But office space also has the third dimension of height. For Forbes Publishing Company, utilization of this third dimension has solved manifold problems while producing greater efficiency.

Forbes' solution revolves around the newly introduced Korda-Room. A development of the functional office furniture which E. I. du Pont de Nemours & Company sponsored for its own use, the Korda-Room manufactured under license by Korda Industries, New York, N. Y., is a movable semiprivate office comprising an L-shaped desk complete with integral partitions, cabinets, desk drawers, bookcases, shelving, and other accessories. The Forbes project is said to be the world's first commercial application of the du Pont-licensed Korda-Room.

FIG. 3 EMPLOYEES USING NEW KORDA ROOM RETAIN PRIVACY BUT HAVE INCREASED WORKING SURFACE COUPLED WITH REDUCED OFFICE-SPACE REQUIREMENTS

Exhaustive investigations made by du Pont, including time and motion studies of executive and subordinate personnel at work, revealed that the du Pont-pioneered functional furniture, while providing the equivalent of a desk and a reference table, reduced office-space requirements 30 per cent or more and permitted up to 35 per cent more people to occupy a given floor space.

Further, the L-shaped desk, with its built-in accessories, puts everything within arm's reach. For workers who constantly refer to records, manuals, reference data, books, and similar material the new type of office furniture seemed to suggest a profitable convenience. Partitions are moved simply by moving the desks. Executives and other employees who formerly required relatively expensive private or semiprivate offices are now housed, more comfortably, in considerably reduced floor space. Over-all attractiveness of office layout has been enhanced, office noise has been decreased, and personnel efficiency and morale increased.

NBS Automatic Computer

THE completion and successful operation of SEAC—the National Bureau of Standards Eastern Automatic Computer—has been achieved by NBS electronic scientists.

SEAC is a high-speed, general-purpose, automatically sequenced electronic computer. It was developed and constructed at the Bureau under the sponsorship of the Department of the Air Force to provide a high-speed computing service for Air Force Project SCOOP (Scientific Computation of Optimum Programs), a pioneering effort in the application of scientific principles to the large-scale problems of military management and administration. SEAC will also be available for solving important NBS problems of general scientific and engineering interest.

SEAC automatically performs all of the logical and arithmetical operations required to solve a particular problem when it is supplied with coded instructions and numerical data. By combining a vast number of simple operations into a complex high-speed sequence, it can calculate the answers to many difficult computational and statistical problems whose solutions otherwise would be impractical in any reasonable time or energy sense.

All operations are carried on in a binary number system, the presence of a pulse indicating "1" and the absence of a pulse indicating "0." In SEAC a sequence of 45 binary digits is known as a "word" and may convey operational instructions as well as numerical data. SEAC's high computing speed is largely the result of two design features: Its rapid pulse rate (1 megacycle per second) and its large memory (512 words) capacity. They make it possible for SEAC to add or subtract pairs of 11-digit numbers 1100 times a second and multiply or divide them 330 times a second. These rates include the time it takes for the machine to search its memory for the numbers, operate upon them, and return the result to the memory. An arithmetical operation of addition or subtraction alone is completed in 50 microseconds; multiplication or division is completed in 2500 microseconds.

SEAC's computing functions are carried on in four main sections: An input-output unit, a memory unit, a control unit, and an arithmetic unit. The input-output unit is the link between the machine and its operators. Here information and instructions are fed in and answers are printed out. The memory unit acts as a file for instructions and numbers while the control unit is directing the flow of information through the

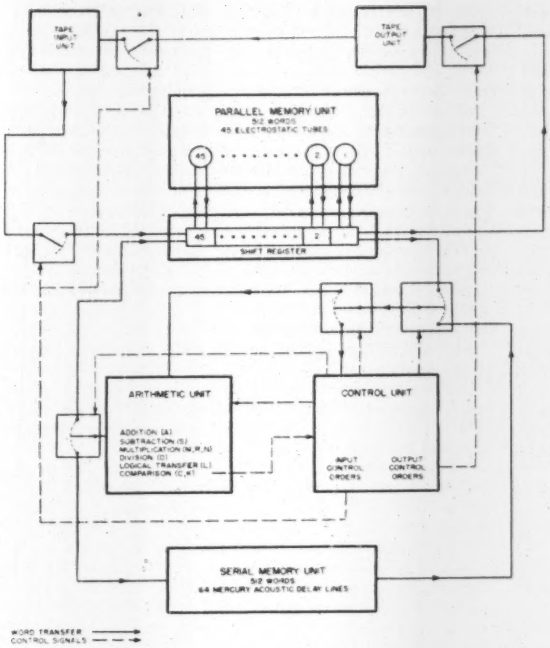

FIG. 4 OVER-ALL BLOCK DIAGRAM OF SEAC

(Switch symbols indicate electronic operations performed automatically under the direction of the machine's control unit. Switching times are about 1 microsecond.)

computer. Signals from the control unit perform the electronic switching which sends numbers and instructions to the right places at the right times. The control unit continually refers to the memory unit for instructions in the proper sequence, and the arithmetic unit carries out the actual computations the control unit directs it to perform. When the arithmetic unit has arrived at the solution required, the control unit directs the memory unit to send the answer to the output unit.

The present input-output unit employs a manual keyboard for direct input and a teletype printer for direct output, using a hexadecimal notation (base 16) to represent numbers and instructions. Indirect operation is accomplished through the use of punched paper tape. SEAC's design allows for the later replacement of the teletype system by a faster magnetic-wire system. The initial model of a magnetic-wire input-output unit with a single serial information channel has already been planned. The time to read a block of eight words in or out with the magnetic-wire scheme is less than a tenth of a second; with the present punched tape it is 16 sec. SEAC is flexible enough to accommodate a wide range of serial or parallel input-output systems, so that future developments can be directly incorporated.

The main memory now operating in the SEAC is a serial unit with a storage capacity of 512 words (8 words in each of 64 acoustic delay lines). A word is stored as a series of sound waves traveling in mercury. Waves generated by a quartz crystal at one end of a mercury-filled tube area are received at the other by a similar crystal. A special amplifier then transforms the sound energy into electrical signals and returns the pulse sequence, at its original strength, to the first crystal. In this way a word is recirculated until it is called for by the control unit. Average access time in referring to a word in the memory is 168 microseconds. Plans for future expansion call for the addition of a parallel memory system of 45 electrostatic tubes storing an additional 512 or 1024 words with an access time of only 12 microseconds.

SEAC has already solved an important problem in optics in the design of lenses and one in thermodynamics; and several mathematical problems of general interest to pure mathematicians were solved earlier for the purpose of testing the machine. In one of these the machine was directed to compute the factors of any given number up to 100 billion. It rapidly determined, for example, that the number 99,999,999,997 has no factors and is therefore a prime number. In order to do this, the machine divided 99,999,999,997 by 80,000 different trial devisors. SEAC generated each of these trial devisors, automatically establishing that each was a prime mover. This problem, which would be two months' work for a man operating a desk calculator 8 hours a day, required 30 minutes for its solution.

Because SEAC was needed for use as quickly as possible, its design was kept simple, and the equipment which had to be built was held to a minimum. SEAC was designed to operate initially as a serial machine because this mode of operation requires less equipment than the parallel method; this does not, however, mean less functional effectiveness. The list of basic operations or orders was kept as short as possible for the same reason. SEAC has seven basic orders, chosen after a careful study which established their convenience for solving the most elaborate problems the machine is expected to handle: Addition, subtraction, multiplication, division, comparison, logical transfer, and input-output control.

The comparison order allows two numbers to be compared to determine which is larger. This feature gives the machine a degree of choice. The result of a comparison thus dictates which of two alternative operational sequences the machine is to perform next. The logical transfer order makes it possible for the machine to alter an instruction it has previously received.

Cantilevered Research Tower

BEHIND a protective screen of rough-weather sheeting is being erected the new S. C. Johnson & Son, Inc., research and development tower, at Racine, Wis. Designed by Frank Lloyd Wright, the famous architect, the structure now looks much like a gigantic silo or grain elevator. But when work is completed, it will be a free-standing glass-sheathed 156-ft-high 15-story tower, dedicated to the development of more and better wax products for home, industry, and agriculture. See frontispiece on page 698 of this issue.

With an inner core of concrete and cantilevered floor levels contained in double walls of glass, it will have the appearance of a giant circular stairway encased in glass.

With its 15 floors for research, supported entirely by this concrete and masonry core through the center, the tower is said to be an outstanding example of cantilever construction. According to the contractors, Wiltscheck and Nelson, Inc., it will probably be the tallest structure ever erected on this construction principle.

The total weight of the tower, some 16 million pounds, will be supported entirely by the central core or stem, which extends 50 ft into the ground to provide such anchorage.

This tapering central footing stem, which is solid reinforced concrete for its first 20 ft, mushrooms out to a 60-ft diam at ground level. Then as it rises above the ground, it becomes a hollow cellular shaft, enclosing two shafts for the air-conditioning exhaust tubes, a supply shaft, an elevator shaft, and a stairway shaft.

Floors are 40 ft square at alternating levels with circular balconylike levels 38 ft in diam in between. These floors will be contained, except for narrow bands of masonry at main-floor levels, entirely in double walls of glass.

The exterior glass wall will be tubular and the interior plate glass. The tubing will be joined or caulked with a specially fabricated Koroseal glazing strip.

The entire project will provide 98,731 sq ft of floor space. About 82 cu yd of concrete was used for each of the tower's main floors, and 9000 yd of concrete was poured, and nearly 1000 tons of reinforcing steel and bar steel used in the project.

With the double glass walls, all floors in the tower will be brilliantly lighted with sunlight, and all floors will be thermostatically air-conditioned, heated, and completely serviced from the central shaft.

Ignitron Locomotive

THE idea of alternating-current power supply, ignitron rectifiers, and direct-current driving motors has worked so well in experimental rail-car service that it is being carried to the next logical step—to full-size locomotives. Two 6000-hp, rectifier-type locomotives are being constructed by Baldwin Locomotive Works and Westinghouse Electric Corporation for freight service on the Pennsylvania Railroad, according to the *Westinghouse Engineer*, July, 1950.

Each locomotive, consisting of two 3000-hp units, produces a maximum tractive effort of 165,000 lb. The total weight of 660,000 lb is carried on 12 axles, all of which are drivers. They will be the most powerful 12-axle electric locomotives ever produced.

Locomotives have been produced with direct-current motors operating from an alternating-current trolley supply. One type of locomotive, introduced in the 1920's, used motor-generator sets to convert the alternating current to direct current. These were good locomotives—most of them are still in service—but motor-generator sets are expensive, bulky, and rather inefficient.

The weight and space advantages gained by using ignitron rectifiers, rather than motor-generator sets, to effect the combination of d-c driving motors with an a-c power supply are dramatically demonstrated by the fact that motor-generator equipment for a 6000-hp locomotive weighs four times as much as the rectifiers and associated apparatus needed to do the same job. Furthermore, the motor generators require longer and heavier locomotive bodies and running gear to house and carry them. Finally, this heavier and larger motor-generator locomotive operates with an efficiency about five per cent below that of the rectifier type.

The fundamental operation of the rectifier locomotive is quite simple. Alternating current from the trolley is collected by a pantograph in the normal fashion, then transformed to low voltage by a transformer on the locomotive. Between the transformer and motors are located the rectifier tubes that convert a-c into d-c power. Speed of the locomotive is controlled by varying the output voltage, by selecting proper taps on the tap-changing transformer.

Several advantages are cited for the ignitron locomotive: It is better suited to heavy-drag service than is the a-c locomotive. The rectifier locomotive is expected to be appreciably better in over-all efficiency than the a-c locomotive. As to power factor, it should be a few percentage points better.

While rectifier locomotive initial costs are still not clear, certain factors weigh heavily in its favor by comparison with the a-c unit. Most of these stem from the fact that the rectifier locomotive will use standardized d-c motors, already well developed and—by comparison with a-c equipments—produced in relatively large quantities for Diesel-electric locomotives.

Two factors make it appear that the rectifier locomotive will require less maintenance. The d-c motor naturally requires less maintenance expense than the single-phase a-c motor, largely because of easier commutating conditions and because the more uniform torque flow lessens the mechanical stresses on bearings and other components.

Also, the motors are the same as those in extensive use on Diesel-electrics.

The rectifier system eliminates right-of-way conversion stations. Ignitron rectifiers operate as well on 60 cycles as on 25. In fact the supporting transformers are only about two thirds as large and as heavy.

Another power-supply simplification is touched off by the rectifier system. If commercial frequencies can be used, then it becomes advantageous to employ commercial voltages. Trolley voltages can be increased several times, if desired, over the 11 kv commonly used. Essentially, this means reducing the number of substations along the right of way compatible with maintaining continuity of service. Also, another factor in the resulting economies is that 60-cycle power-distribution apparatus is standard and is built in relatively large quantities—with consequent cost advantages.

Materials Handling

Railroad Freight-House Mechanization

HOW mechanical handling of freight was inaugurated at the Kansas City freight house of the Atchison, Topeka and Santa Fe Railway Company, was outlined by W. H. Roehrig of that company during the 1949 ASME Annual Meeting in New York, N. Y.

He pointed out that at the close of the war in 1945, industry began such an extensive conversion to peacetime production that by January, 1946, there was a tremendous volume of less-than-carload traffic thrown upon the rail carriers. This resulted in more merchandise being shipped than railroads or other forms of transportation could handle currently. Railroad freight houses, which were not built to handle such a volume, became congested. Railroads had no mechanical equipment other than a few electric and gasoline-driven tow tractors. It was apparent that manually operated two-wheel trucks could not move the freight fast enough to appreciably alleviate the problem and the labor situation grew worse instead of better. At this time, railroads awoke to the need for some mechanical handling of freight in their freight houses and at transfer points.

There was little freight that was not man handled, and heavy shipments weighing tons were taken from cars or put into cars by brute strength alone.

Familiarity with freight-house operations and with the factors which contributed to their efficiency or inefficiency, pointed the way to the development of a method for measuring the comparative efficiencies between freight-handling facilities. The rating plan developed, when applied to any situation,

uses six leveling factors. The application of these factors reduces the final result to an efficiency-rating basis. The leveling factors are as follows: (1) Tonnage handled; (2) distance freight is transported; (3) type of freight; (4) type of cars loaded and unloaded; (5) unusual situations, such as congestion, traffic density at certain periods of day, physical handicaps, uncovered docks, etc.; and (6) efficiency of supervision and labor.

Regardless of the type of freight house, the fact remains that 80 per cent of less-than-carload freight is moved through it between 2:00 p.m. and closing time.

Congestion in the aisles and on platforms at Kansas City was such that the amount of tonnage that could be handled daily was limited. Manually operated two-wheel trucks filled the freight house and platforms so that truckers stood idle a great portion of the time waiting for someone up ahead to clear the runways so they could proceed. The first machinery, procured early in 1946, consisted of both chore-boys and fork-lift trucks. Improvement was noticeable in relieving the congestion in the freight house almost at the outset and continued steadily as greater efficiency was attained in the operation of the machines and the acquisition of a greater number. Four-wheel rubber-tired roller-bearing flat-bed trucks were secured, and these and the chore-boys were equipped with Mercury safety couplers so that four-wheel trucks could be handled by the chore-boy as well as the gasoline-driven tow tractors previously used at this facility. Efficiency at this depot became such that 30 to 35 per cent greater tonnage was handled daily within a short period of time and per unit handling cost reduced materially. At the outset, the company used about 900 two-wheel trucks here, which number has been reduced now to 25 for miscellaneous uses.

While freight-handling capacity was increased and speeded up with substantial reduction in unit costs, some of the freight-house forces who were supplanted by machines were retrained as machine operators and maintenance men for the machinery. The others were employed as stowmen. An increased number of stowmen was necessary because of the volume and speed with which machinery brought freight to cars for loading, stowing, and bracing; also some of these men were trained in the application of bulkheads, of which an increasing number was constantly being applied to loaded cars.

Operation with fork-lift trucks is with and without pallets. However, much of the freight lends itself to handling by fork-lift without being placed on pallets. A large portion of this freight is placed on pallets either at the tail gate of the truck for movement into cars or on pallets in cars for movement to tail gate of trucks.

Drums of paint and oil, machinery of different sizes and shapes, tombstones, farm machinery, tanks, refrigerators, stoves, pianos, and similar objects are handled without pallets. Bags of hardware, pails of paint, small oil drums, tires, canned goods, fresh and cured meats, and many small items are placed on pallets for handling by the fork-lift trucks. One of the reasons for the better showing of the fork-lift in tonnage handling is by reason of its greater utility in being able to pick up and move freight without the operator leaving the machine, as is necessary in the case of the chore-boy or similar machine whose driver is required to do this work. On the other hand, the chore-boy draws loaded flat-bed four-wheel trucks, but the island platforms are so narrow at Kansas City that congestion occurs when tonnage is running heavy to outbound cars and mobility of these machines is not as great as a fork-lift, which can maneuver in and out of congestions to better advantage.

Both of these machines fit into the picture for operation at Kansas City and other stations, and as the personnel become more and more mechanically minded, further improvements will result.

At the present time all of the Santa Fe's principal freight stations and transfer points have been mechanized, either wholly or to a degree as it is felt the particular facility requires mechanizing. Early in the program it was found that two-wheel-truck operation with machinery could not be intermingled very well since the machines were slowed down to the tempo of two-wheel-truck operation, and for this reason the number of two-wheel trucks at the mechanized stations have been reduced to a minimum.

Handling Railroad Materials

In another paper also presented at the 1949 ASME Annual Meeting, Carleton W. Mayer, Assoc. Mem. ASME, assistant to the president of the Chesapeake and Ohio Railway Company, focused attention not on the handling of freight shipped on the railroads, but upon handling the constant flow of supplies required by the railroad itself.

To keep a railroad rolling and in good condition, Mr. Meyer stated, requires a constant flow of fuel, material, and a host of other articles—a flow of the same order of magnitude as the raw materials consumed by the largest of manufacturing industries.

For example, in 1948, the C.&O. consumed more than 4½ million tons of fuel coal; 93,000 tons of steel rail, track fastenings, and accessories; 14,500 tons of steel bars, plates, and sheets; 1,100,000 crossties; 22,500,000 board feet of other timber and lumber. Besides these major items, manufactured articles range all the way from large pieces of machinery to paper clips for the office.

These articles are purchased from suppliers, virtually all over the country. They are shipped in, either direct to the point of use in some places, or to company stores in others. From the stores, they are shipped when, where, and in quantities, as needed by those who use them.

This department employs an average of 754 people, with annual payroll and other expense of $2,300,000. Thirty-four stores depots, with considerable mechanical equipment, provide facilities for the operation.

Total dollar volume of C.&O. purchases in 1948 was $77,500,000. Value of scrap and second-hand materials sold totals $6,000,000 annually. In addition, and not included in these figures, is the value of serviceable materials reclaimed and returned to inventory.

Handling of company materials on the railroad is not one problem, but several. Each phase will be found to be remarkably similar to problems presented in one or more other industries.

For example, the 4½ million tons of fuel coal purchased by the C.&O. in 1948 is an impressive volume of bulk material. This coal was loaded in railroad cars at mines, with the regular tipple equipment of the mine operators. Some of the cars went direct to coaling plants and were unloaded into bins, going down through chutes into locomotive tenders. Others were unloaded into storage piles which the railroad must maintain for a margin of safety. From storage piles they were reloaded into cars and handled to coaling plants. In some instances, at smaller terminals, coal was loaded into tenders directly out of cars by clamshell buckets or other suitable means.

Crushed-stone ballast is loaded into railroad cars at quarries and goes out to the place where used. The normal procedure is to load in coal hopper cars and to unload by opening the hopper over the part of the track where the ballast is to be used.

Crossties and other large timber pieces represent one cate-

gory; lumber another. Ties move from the forests, where they are purchased, to the treating plants. For example, the tie-treating plant at Russell, Ky., the principal one on the C.&O., is operated by the Koppers Company under contract. Fork trucks unload and stack the ties for seasoning. Then the ties move through the treating plant, where they are loaded out to line of road for use. Ties are adzed and prebored before treating. Other structural timbers are similarly seasoned, preframed, and treated.

Steel rails are loaded on gondola cars at the steel mill and normally go direct to the job. The materials-handling problem is posed by the characteristics of the object—a heavy piece of steel, nearly 40 ft long and weighing nearly a ton. Spikes, bolts, and other small items come in kegs, each weighing approximately 200 lb. Tie plates are shipped loose in bulk in gondola cars and are unloaded with a magnet. A variety of other steel items are used for locomotive repair, car repair, bridges and other large structures, and thousands of miscellaneous jobs. The biggest tonnage is for fabricating at the car repair shop at Russell, Ky. Plates and sheets are purchased direct from mills. Car sheets are $^3/_{16}$ or $^1/_4$ in. thick, and range up to 165 in. long and 57 in. wide. They are handled on pallets.

Parts for car repair—rivets, nuts and bolts, draft gear, center plates, brake beam parts, and the like—are also handled on pallets.

Other materials are handled through stores. These range from locomotive cylinders to cotter pins.

Used and scrap materials—reclamation—is also a large activity. This is located in a plant at Barboursville, near Huntington, W. Va., and is normally manned by 325 to 350 employees. It consists of a rail and scrap yard; rail sawing mill; frog, switch and crossing—repair and reclamation work; equipment repairs; bridge and building forces; signal shop; section storekeeper—track material; and storeroom.

Periodic surveys of handling practices have been made and it is believed that they compare favorably with modern industrial practice. During 1931 a survey was made and the Stores Department purchased and placed in service a limited amount of materials-handling equipment. This equipment gradually has been added to until now the following is in use: 36 gasoline and electric-powered units consisting of fork-type trucks, Hi-Lo lift trucks, crane trucks, flat-bed trucks and tractors; 900 wood and steel pallets; 750 box-type pallets (skids); 700 trailer wagons; and 150 special trailers for handling wheels and lumber.

Before palletizing it took four men eight hours to unload an 80,000-lb carload. Now, three men do the job in four hours. The boxes are palletized in the car and taken by fork trucks to the oil-storage house. They are loaded out by fork truck, sometimes taken off pallets in the car, or left on pallets, if the quantity and handling facilities at the other end justify.

The pallet methods are typical for other materials such as arch brick for locomotives, wire nails, roofing paper, chemicals for water treating, and bolts and nuts.

A distinctive feature of the railroad service of supply is the "supply train"—a storehouse on wheels. It makes the rounds once every 90 days—one month west of Huntington, W. Va., the next month east of Huntington, with a one-month layover. Requisitions come in and the necessary articles are loaded. The train goes out with a considerable load—15, 20, or 25 cars. One car provides living quarters for storekeeper and his crew.

Gasoline and oil are piped from the train's tank cars direct to storage tanks at the tool house. Scrap is picked up by a burro crane with a magnet. Track tools and materials and all other articles needed are delivered direct to section tool houses; scrap and old tools are picked up. This promotes good housekeeping all along the line.

Fluid-Energy Pulverizer

THE development of a fluid-energy-type pulverizer, its design features and major components, general operating characteristics, and recent application to steam-generating units was described by L. D. Bechtel, power-plant consulting engineer, Carroll, Bechtel and Langtry Division of the Commercial Testing and Engineering Company, Chicago, Ill., and G. M. Croft, manager, fuel equipment department, Blaw Knox Division, Blaw Knox Company, Pittsburgh, Pa., during the 1950 ASME Spring Meeting in Washington, D. C.

Preliminary experience with the fluid-energy pulverizer indicated that a pulverization better than 90 per cent through 200 mesh screen was possible. Such fineness of pulverization will have the following effect on the application to steam-generating equipment: (1) Permit more rapid burning and, therefore, shorten flame length; (2) reduce slagging tendencies on tubes and walls because of the extreme fineness of pulverization; (3) fine pulverization permits improved air-fuel mixture, resulting in better combustion with less excess air, thereby reducing stack temperatures and increasing operating efficiencies; (4) reduces the ash particle size to such a small increment that abrasive action on economizers, air preheaters, and boiler tubes is substantially reduced and that in many locations it is not necessary to install fly-ash-removal equipment.

Fluid-energy pulverization is accomplished by collision of particles, or impingement of particle upon particle, suspended in a gaseous atmosphere, but moving at different velocities. Collision may be classified arbitrarily in two categories—

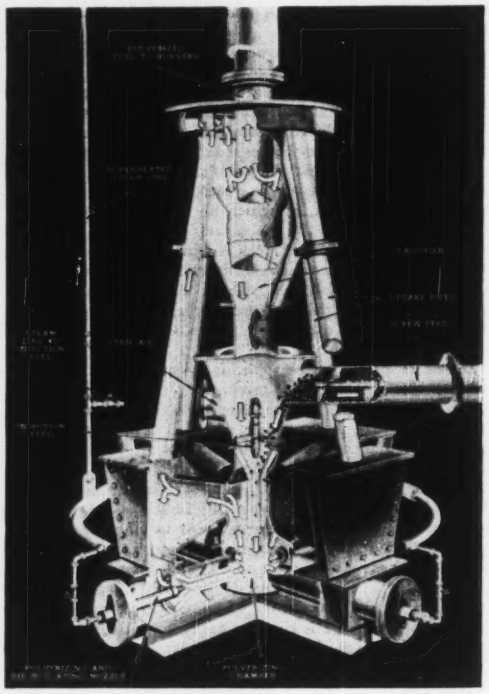

FIG. 5 DIAGRAMMATIC ARRANGEMENT OF FLUID-ENERGY PULVERIZER

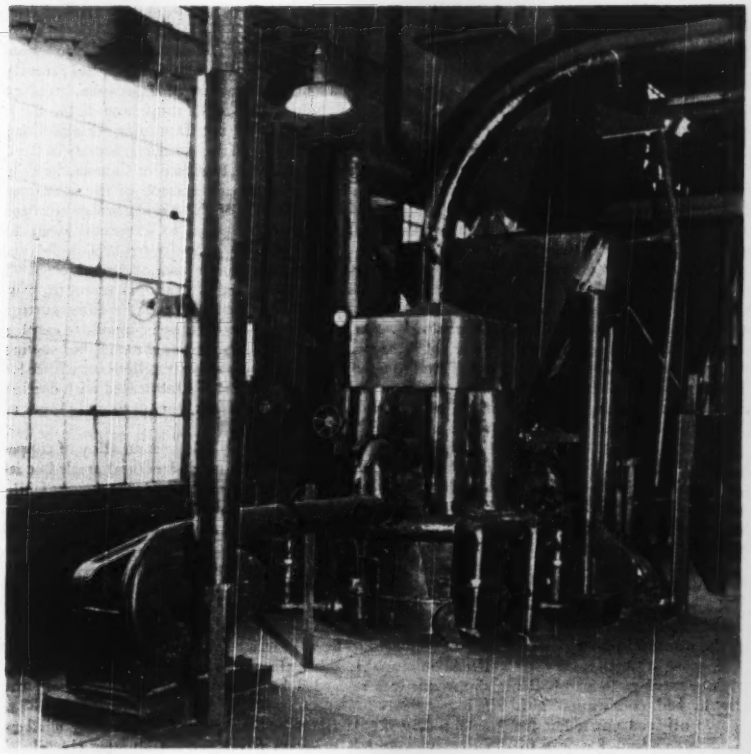

FIG. 6 ACTUAL APPLICATION OF FLUID-ENERGY PULVERIZER SHOWING PULVERIZER UNIT AND FUEL FEED HOPPER STRIP AIR ASSEMBLY

glancing collisions where abrasion takes place by rubbing, and direct collisions, where the particles are fractured by striking one another head on. However, the principal grinding effect is due to the collision of particles not moving in the same general direction, and it is for this reason that the fluid-energy pulverizer is capable of pulverizing to a fine degree those hard materials which normally do not break down so readily. A diagram of the fluid-energy pulverizer is shown in Fig. 5.

The pulverizer operates under a pressure of 100 psig at the nozzles, with the motivating power (either steam or air) superheated to a total temperature of 750 F. The impingement velocity is greater than 300 mph. It is evident therefore, that the kinetic energy created by this jet action is of sufficient magnitude to produce extremely fine pulverization of even the hardest materials. Local conditions usually indicate the most economical fluid energy to use.

By the use of superheated steam or air at 750 F or better, it is possible to dry out wet materials during the process of pulverization; thus the fluid-energy pulverizer acts both as a drier and a pulverizing device. Actual operations indicate the unit can readily handle coals containing a total moisture in excess of 20 per cent with little or no reduction in capacity.

The pulverizer operates free of vibration and with no more noise than experienced with an average fan. If the strip air fan is located, as it can be, at a distance from the pulverizer, there is practically no noise from the unit itself.

A unique feature of this fluid-energy pulverizer is the absence of moving parts. With the exception of the screw mechanism, which feeds the material from the hopper to the pulverizing zone, there are no moving parts on the unit.

One of the first applications of the fluid-energy pulverizer was to a 400-hp, 4-drum Heine bent-tube boiler set eight feet from the operating floor to the center of the bottom drum, originally designed for stoker firing. The boiler delivers saturated steam at 160 psig to the main steam header of the power plant. No heat-recovery equipment, either superheater or economizer, was employed in the unit.

For operating the pulverizer, saturated steam was taken from the main steam header and superheated by means of an external superheater located alongside of the boiler furnace, taking gases direct from the furnace. After passing through the pulverizer, the steam and coal mixture was blown into the furnace through a pulverized-coal burner. Air for combustion was furnished by a motor-driven forced-draft fan and injected at the burner. The furnace was refractory-lined throughout, there being no waterwalls or air cooling.

ASME boiler tests were conducted to determine the combined operating characteristics of the boiler and pulverizer equipment including the external superheater. For the efficiency test the boiler was operated at 140 per cent of rating. The average feedwater temperature was 174 F; average flue-gas temperature 497 F, and the actual evaporation was 10.68 lb of steam per lb of coal. The coal consumed was a West Virginia $^{3}/_{4}$ in. × 0 screenings, having 6 per cent moisture, 6 per cent ash, 31 per cent volatile, 50 per cent fixed carbon, and a heat content of 13,700 Btu per lb. Results of the test indicated a gross combined efficiency of 81.7 per cent with a net combined efficiency of 74.3 per cent.

In addition, a fly-ash emission and coal-fineness test was conducted on the boiler unit, and it was determined that the dust loading in the stack, with no dust-collecting equipment installed, was 0.54 to 0.63 grains per cu ft of flue gas emitted, with approximately 75 per cent of the ash from the coal being discharged up the stack. The fineness of the coal pulverized ranged from 90 to 95 per cent through a U. S. Standard 200-mesh sieve at a total superheated-steam temperature of 775 F and a steam pressure to the mill of 100 psig.

Two later applications discussed by the authors include (1)

an installation which consumes a low-grade bituminous coal, and (2) one which uses a blend of coke breeze and bituminous coal.

Actual acceptance-test results on the unit using the low-grade bituminous coal indicated that the average temperature of the steam generated was 440 F, from which the steam required for pulverization was taken and superheated, by means of an external superheater, to an average total temperature of 820 F. The average temperature of the coal mixture from the pulverizer to the burner was 230 F and the strip air temperature averaged 335 F. Average flue-gas analysis indicated carbon dioxide at 12 per cent, oxygen at 7 per cent, and carbon oxide at zero per cent. Equivalent evaporation was approximately 8.5 lb of steam per lb of coal when developing 900 hp or 180 per cent of rating. The combined efficiency averaged about 73 per cent, and the furnace heat release was approximately 20,000 Btu per cu ft per hr. The fineness of pulverization, determined from many samples by air-flotation method, averaged approximately 97 per cent through 100 mesh, 94 per cent through 200 mesh, and 93 per cent through 325-mesh screens. At a pulverizing rate of 4000 lb of coal per hr the unit steam consumption for pulverization averaged 0.38 lb of steam per lb of coal.

The boiler units were Babcock & Wilcox Class S-26, four-drum stirlings, bent water-tube type of approximately 500 hp each, including Foster-Wheeler superheaters, and three Peabody-type A-15 wide-range mechanical atomizing oil burners per boiler. Normal operating steam conditions are 150 psig and 80 F superheat.

The furnace setting for each boiler unit was of the air-cooled wall type. The only change required was to rebuild the furnace floor to provide proper circulation of air from the side and front walls across the floor to an intake manifold serving a new forced-draft fan.

The existing forced-draft fan, only one serving all four boiler units, was obsolete and physically in bad condition. This unit was maintained for the other two oil-fired units, but for each coal-oil fired boiler unit a new forced-draft fan was installed providing the proper control for air-fuel rate.

Existing Bailey automatic combustion control was maintained with only one additional control unit being required and that was for coal feed, thus providing automatic combustion control for either type of fuel.

In the second case the fluid-energy pulverizer was installed on a Babcock & Wilcox horizontal-tube 4-drum boiler having a a rated capacity of approximately 976 hp, see Fig. 6. This boiler is fired by a Westinghouse underfeed stoker. The boiler and stoker are about 30 years old, but in good physical condition. The boiler is equipped with a superheater giving approximately 100 F superheat and the operating steam pressure is 200 psig. The boiler is also equipped with an economizer and induced-draft fan, as well as a forced-draft fan. There are no water-cooled furnace walls or air-cooled furnace walls. Furnace volume is approximately 3000 cu ft. Normal operation of boiler with stoker is approximately 200 per cent with a peak of 240 per cent.

At the time that this paper was presented, this unit had been in continuous operation for approximately three months. The interruption by the steel strike has severely delayed the taking and interpretation of operating data although the unit operated continuously all during the strike. Other than the fact that the sustained boiler rating can be increased from 200 to 300 per cent by use of the pulverizer in conjunction with the stoker, no conclusive data are available at the moment. The indications are, however, that the pulverization of a blended mixture of coke breeze and bituminous coal does produce a blended fuel which will give satisfactory performance.

Aluminum Bridge

THE world's first all-aluminum highway arch bridge which spans the Saguenay River at Arvida, Quebec, has recently been completed. This unique structure of 290-ft span, involved new engineering techniques in mill, shop, and field, C. J. Pimenoff, structural designer of the Dominion Bridge Company, Ltd., told a joint meeting of the American Society of Civil Engineers and The Engineering Institute of Canada, held in Toronto, Canada. Fabrication and erection of the structural aluminum for the superstructure of the Arvida bridge required modifications of some practices usual to structural steel, he said.

High-strength structural aluminum cannot be subjected to temperatures above 350 F and still retain its strength, Mr. Pimenoff stated. This characteristic eliminated flame cutting and welding. At first it was frustrating to be unable to employ either of these two widely used operations, he said, but sawing was found to be so easy that it became an excellent substitute for flame cutting. A band saw, generously lubricated with cutting fluid, traveling at a speed of 1200 fpm, cut plates and shapes to required sizes easily.

Structural aluminum used in this bridge is an alloy of copper having a strength about equal to mild structural steel, but its weight is only one third that of steel. Its light weight facilitated handling, most pieces being lifted and moved around by men instead of by cranes and hoists. Aluminum shapes and plates are relatively corrosion-proof and except for inside surfaces no protective painting was used.

Fabrication called for better than average accuracy of shopwork because only $^1/_{64}$ in. clearance is allowed between rivets and the rivet hole, and because field drifting and moderate forcing of members to fit as practiced with structural steel are believed inadvisable with aluminum. Greater accuracy in the shopwork was rewarded by better fit during erection in the field.

Gun-driven cold rivets had not proved satisfactory until an extensive research program developed an annular rivet head suitable for a hand-held pneumatic rivet gun. A $^3/_{16}$-in. hole $^3/_8$ in. deep is made in the end of the rivet, into which fits a projection in the snap of the gun. As the rivet is driven, the gun is rolled forming the annular head. The average driving time of these cold-driven rivets was about 40 sec. Rivets are made from hot-rolled and cold-drawn aluminum rod. Most shop rivets were machine-driven but all field rivets were cold-driven by a hand-held gun.

The main arch is a built-up box section 54 × 32 in., made up of two aluminum web plates, four flange angles, and two cover plates. The circular arcs for the curve of the arch, which rises 47 $^1/_2$ ft above the abutments, were laid out full size on the shop floor, and the ribs were built onto them. Flange angles were gradually bent cold to exact shape by successive passes through large angle rolls, and before acceptance were examined for minute cracks under fluorescent light.

The bridge was erected without falsework supports. Despite its 65-ft length the heaviest rib section weighed only 6 $^1/_2$ tons. This lightweight for the heaviest piece and previous satisfactory experience with cableways made this method of erection a natural choice.

Each rib was shipped in six sections. At the site, the cableway held successive sections to accurate positions while they were bolted to the sections previously set and until the load was gradually transferred from the cableway to temporary 1 $^1/_2$-in-diam wire-rope tiebacks anchored on shore. The closing section at the crown of the arch fits tight at the bottom and within $^1/_8$ in. at the top of the rib after tiebacks were released. The arch supports a concrete roadway.

ASME TECHNICAL PAPERS

Substance in Brief of Papers Presented at ASME Meetings

Hydraulics—Petroleum

New Method for Bulk Modulus Determinations, by S. Logan Kerr, Mem. ASME, S. Logan Kerr & Company, Inc., Philadelphia, Pa., and Lewis H. Kessler and Merrill B. Gamet, Northwestern Technological Institute, Evanston, Ill. 1950 ASME Semi-Annual Meeting paper No. **50—SA-32** (mimeographed, to be published in Trans. ASME).

IN any computations concerned with so-called "water hammer" or surge conditions occurring when the flow rate of a liquid is changed in a closed conduit, the compressibility of the liquid and the elasticity of the conduit walls have a major effect upon the magnitude of the surge, as well as its distribution along the conduit.

The magnitude of the surge is directly proportional to the velocity of the surge wave and this, in turn, is affected by the diameter, thickness, materials of construction, and modulus of elasticity of the pipe walls. The character of the liquid in the pipe line also enters into the conventional equation for surge wave velocity, with both specific gravity and compressibility affecting the values.

The specific gravity under various temperatures and pressures can be determined without great difficulty. The compressibility factor, more commonly expressed as the bulk modulus of compressibility, is not so easily arrived at.

The bulk-modulus value for water at ordinary temperatures and pressures has been reported in a number of publications and is commonly taken as 300,000 psi for most surge calculations.

The bulk modulus of fluids other than water has not been reported in engineering literature to any great extent, particularly in the range of pressures and temperatures ordinarily encountered in petroleum-pipe-line work (0 to 1500 psi, and 32 F to 100 F).

To make surge investigations in advance of construction of a pipe line requires some knowledge of the velocity of the pressure wave within the system for computing the magnitude of surges which might be expected due to ordinary routine operation or due to emergency conditions.

The physical characteristics of the materials and construction of the pipe line itself are fairly well known. The remaining factor relates to the physical characteristics of the liquid and it is to these matters that attention is directed in this paper.

Attenuation of Surges in Long Pipe Lines, by Milton Ludwig, Standard Oil Company of California, San Francisco, Calif. 1950 ASME Semi-Annual Meeting paper No. **50—SA-26** (mimeographed).

THE simple water-hammer theory, which neglects the effects of friction, is not applicable to long oil pipe lines for which the friction loss may be 5 to 10 times the initial surge pressure caused by sudden stoppage of flow. For such lines, the initial sudden rise of pressure is followed by a gradually rising pressure which may reach a value several times the initial surge before return of the reflected wave. The effect of sudden stoppage of flow at the upstream end of the line is similar, except that an initial sudden drop of pressure is followed by a slowly falling pressure. Similar surges of lesser magnitude take place at intermediate points along the line. Equations and charts are developed for determination of these pressure-time relations. The theoretical results have been checked against actual tests on 20 miles of 6-in. line in West Texas.

This paper develops a general solution for a single important case of transient flow in a long pipe line, namely, the evaluation of the pressure-distance-time relations existing along a long pipe line after sudden stoppage of flow at either the input or outlet end. The analysis is for a semi-infinite line and is, therefore, rigorously accurate only during the time required for a surge to travel to the distant end of the line and return. Solutions will be developed for both laminar and turbulent flow conditions. The laminar-flow case applies to only a few operating pipe lines but its solution is relatively simple and serves as a point of departure for the more difficult turbulent-flow case. The general equations for transient laminar flow are linear second-order partial-differential equa-

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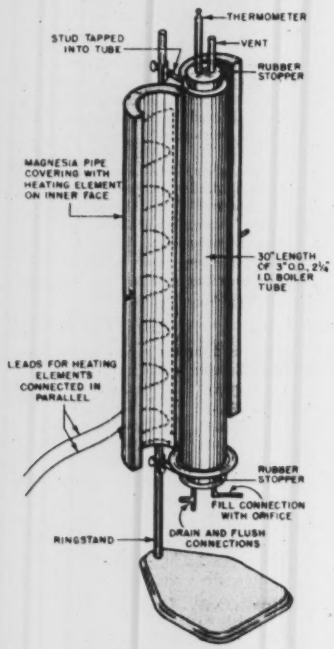
tions, identical to the electrical transmission line, or "telegraph" equations. The partial differential equations for turbulent flow are nonlinear and consequently much more difficult to handle. It has been necessary to resort to a combination of asymptotic solutions, trial and error, and graphical methods in order to obtain the desired results. The solutions have been developed in terms of dimensionless parameters, or ratios, so that the final charts can, within the limitations already stated, be used for any pipe line handling liquid, regardless of size, initial pressure gradient, or initial velocity.

Boiler Feedwater Studies

Chemical Removal of Copper From Boilers, by R. G. Call and W. L. Webb, American Gas and Electric Service Corporation, New York, N. Y. 1950 ASME Semi-Annual Meeting paper No. **50—SA-34** (mimeographed).

WHEN acid cleaning a one-million-lb per hr boiler for removal of deposits which were predominantly iron oxide, the boiler metal was heavily plated with copper. During subsequent operation this copper became detached in large sheets such as to adversely affect circulation, making copper removal mandatory. Because laboratory tests on previously used copper solvents gave poor performance, a solvent was developed containing ammonium persulphate, ammonium hydroxide, and caustic soda which when used on this boiler removed about 300 lb of copper. Laboratory conclusions and field cleaning procedures, results, and costs are indicated.

The boiler from which copper was chemically removed is designated as Boiler "A" located in the Appalachian Electric Power Company's Logan Plant at Logan, W. Va. It is a 6-drum, bent-tube, tangentially fired, dry-bottom unit rated one million lb per hr, 1350 psi, 925 F total steam temperature. This boiler first went into operation in November, 1937. Boiler "A" has been acid-cleaned three times, in January, 1948, March, 1949, and January, 1950, the latter cleaning including the subsequent use of a solvent for removing copper.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STUD TAPPED INTO TUBE
VENT
RUBBER STOPPER
MAGNESIA PIPE COVERING WITH HEATING ELEMENT ON INNER FACE
30" LENGTH OF 3" O.D., 2¼" I.D. BOILER TUBE
LEADS FOR HEATING ELEMENTS CONNECTED IN PARALLEL
RUBBER STOPPER
FILL CONNECTION WITH ORIFICE
DRAIN AND FLUSH CONNECTIONS
RINGSTAND

TEST APPARATUS FOR STUDYING CHEMICAL CLEANING PROCEDURES FOR BOILERS

Process Industries

Process Heating by High-Temperature Liquids, by Paul L. Geiringer, American Hydrotherm Corporation, New York, N. Y. 1950 ASME Semi-Annual Meeting paper No. **50—SA-22** (mimeographed).

THIS paper attempts to show the superiority of liquid heating to other methods now in use in the field of high-temperature industrial processing in the temperature range of 250 F to 1200 F. A brief evaluation of the numerous existing heating methods, and a comparison of steam and chemical-vapor heating to that of a circulating-liquid heat carrier is made.

The various liquid heat-transfer agents available, their applicability to high-temperature processing, and the fundamental equipment designed for such service are discussed. Emphasis is placed on the 400 F to 1200 F temperature range.

The paper concludes that:

1 Liquid heat-transfer systems are better adapted to surface temperature uniformity, close temperature control, and alternate heating and cooling processes than vapor or gas systems.

2 Up to requirements of 400 F, water is unsurpassed as the heat-transfer agent.

3 For high-temperature requirements, the following organic liquids show excellent characteristics: (*a*) 400 F–550 F; Hydrotherm 500 (belonging to Aroclor group). (*b*) 600 F–650 F; Hydrotherm 700 (silicate group). (*c*) 650 F–700 F; Dowtherm A, or Hydrotherm 700.

4 For very high temperatures, 700 F to 1200 F, an eutectic salt mixture (Hydrotherm 1200) exhibits properties that foretell its increasing use in this range.

Metals

Metals for High-Pressure Hydrogenation Plants, by G. A. Nelson, Shell Development Company, San Francisco, Calif. 1950 ASME Semi-Annual Meeting paper No. **50—SA-3** (in type; to be published in Trans. ASME).

MANY of the important chemicals of today's industrial economy require processing in the presence of hydrogen at elevated temperatures and pressures, at some stage in their manufacture. The more familiar ones are ammonia, methanol, edible oils, and higher alcohols. In the petroleum-refining field, hydrogenation processes are becoming more and more important. In the future it can be anticipated that greater need for hydrogenation processes may arise, for example, hydrodesulphurization of crude oils or fractions therefrom, hydrogenation of carbon monoxide (Fischer-Tropsch), and destructive hydrogenation of oil residues or coal (Bergius process). These processes operate at high temperatures and pressures, where ordinary steels have their limits for safe operation. Although high-alloy steels can be used under these conditions, oftentimes more reasonably priced low-alloy steels are satisfactory. This paper summarizes the results of tests and data from operating plants, from which it is possible to establish practical operating limits for carbon and alloy steels for all degrees of severity of service. Additional corrosive effects by sulphur, nitrogen, and carbon monoxide are discussed.

It is concluded that (1) In order to produce damage to the structure of carbon steel by hydrogen, both high pressures and high temperatures are required; (2) carbon steel varies in its resistance to attack with the manufacturing methods; and, in order to build commercial plants, limits for this material should be at a level where steel in its average condition will be adequate; (3) for protection against damage to steel by hydrogen, relatively small amounts of carbide-stabilizing elements are required; (4) when other corrosives are present in the

process streams, measures for protection against these elements should be taken in addition to those required for resistance to hydrogen damage.

Cutting Fluids—Metal Cutting

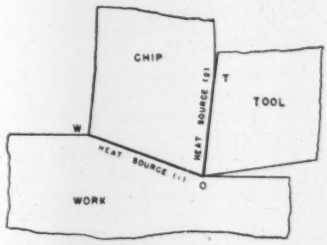
The Effect of the Cutting Fluid Upon Chip-Tool Interface Temperature, by M. C. Shaw, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass., J. D. Pigott, Jun. ASME, The Draper Corporation, Hopedale, Mass., and L. P. Richardson, Jun. ASME, Shell Development Company, Emeryville, Calif. 1950 ASME Semi-Annual Meeting paper No. **50—SA-19** (in type; to be published in Trans. ASME).

AN analysis is presented of the short-circuiting effect of a cutting fluid in conjunction with chip-tool interface temperature measurements by the tool-work thermocouple technique. An experimental arrangement based upon the results of this analysis and capable of giving reliable cutting temperatures in the presence of fluids is described. The temperature-reducing characteristics of a representative group of water-base cutting fluids is studied, and these experiments reveal that the fluids become less effective in reducing the cutting temperature as the volume of metal removed per unit time is increased. The water-base fluids considered are found to reduce the tool-tip temperature by a cooling action to a greater extent than by a reduction of the friction force on the face of the tool.

An Analytical Evaluation of Metal-Cutting Temperatures, by K. J. Trigger, Mem. ASME, and B. T. Chao, University of Illinois, Urbana, Ill. 1950 ASME Semi-Annual Meeting paper No. **50—SA-1** (in type; to be published in Trans. ASME).

THIS paper presents an analytical method for the determination of metal-cutting temperatures. The average tool-chip interface temperature is calculated by considering the mechanism of heat generation during metal-cutting operations in which a type 2 chip is formed. The analytical results agree well with those obtained by test methods, and the theoretical analysis has also yielded some important physical quantities and measurements which affect cutting temperatures.

It was found that (1) The cutting forces decrease with an increase in cutting speed; (2) the contact area at the tool-chip interface decreases with an increase in cutting speed; (3) the tool-chip interface temperature is composed of two components; (4) at low cutting speeds the principal factor affecting tool-chip interface temperature is the deformation at the shear zone; (5) at higher cutting speeds the tool-chip friction is an important factor in the interface temperature; (6) an increase in cutting speed lessens the temperature rise at the shear zone and increases the temperature rise due to the tool-chip friction; (7) the proportion of the "interface" heat going to the chip increases with an increase in cutting speed; (8) lower tool-chip interface temperatures are encountered in orthogonal cutting than obtain with conventional turning in which the nose radius is an active part of the tool; and (9) tool-chip interface temperatures may be calculated with reasonable accuracy by the methods developed in this investigation.



SOURCES OF HEAT IN METAL CUTTING, TYPE 2 CHIP

Residual Stresses in Machined Surfaces, by Erik K. Henriksen, Cornell University, Ithaca, N. Y. 1950 ASME Semi-Annual Meeting paper No. **50—SA-27** (mimeographed).

EXPERIMENTS on measuring stresses in castings for precision equipment in the early 1930's led to an investigation of stresses formed by the cutting action.

The stress-inducing effect of single-point tools working in steels with varying carbon content has been studied, and methods for computing the stresses induced have been developed.

Highly concentrated stresses (up to 100,000 psi) are produced. In ductile materials such as carbon steel the stresses are generally tensile, in cast iron they are compressive.

Methods of investigation are described and data given for stresses produced in various materials, by various tools, and under various cutting conditions.

The principal result of the experiments is that extremely high residual stresses are induced in the surface of a piece of metal by the action of a cutting tool even when light cuts are taken.

Mechanics

The Design of Resonant Quartz-Crystal Ultrasonic Transducers for Research Purposes, by G. W. Swenson, Jr., and W. T. Thomson, Mem. ASME, The University of Wisconsin, Madison, Wis. 1950 ASME Semi-Annual Meeting paper No. **50—SA-12** (in type; to be published in the *Journal of Applied Mechanics*).

ULTRASONIC waves have become an important research technique in many fields, including chemistry, mechanics, and others. Piezoelectric crystals excited by a source of alternating voltage are commonly used as a method of producing ultrasonic mechanical vibrations for such purposes. Hence it is often necessary that crystal transducers be designed, and to those unfamiliar with the theory of piezoelectricity, such a design problem may entail time-consuming research. The present paper is intended to co-ordinate the several approaches to the design problem and to present a practical method for designing quartz-crystal transducers for ultrasonic frequencies.

The Solution of Elastic Plate Problems by Electrical Analogies, by R. H. MacNeal, California Institute of Technology, Pasadena, Calif. 1950 ASME Semi-Annual Meeting paper No. **50—SA-23** (in type; to be published in the *Journal of Applied Mechanics*).

A DYNAMIC-ANALOGY method for the solution of elastic plate problems is described in this paper. The electrical circuits developed here can be set up and studied on an electric-analog computer. Problems involving deflections under constant load, transient vibrations, or normal modes can be solved in this way. The method of applying boundary conditions to plates with irregular edges is given, together with a detailed description of the representation of the boundary conditions for a rectangular variable-thickness plate. Solutions that have been obtained on the Cal Tech electric-analog computer are presented for the static deflections and normal modes of a rectangular cantilever plate.

Thermal Effects in Calendering Viscous Fluids, by M. Finston, Massachusetts Institute of Technology, Cambridge, Mass. 1950 ASME Semi-Annual Meeting paper No. **50—SA-13** (in type; to be published in the *Journal of Applied Mechanics*).

CALENDERING (rolling) of plastics at high speeds produces blistering and peeling which are attributed to a combination of uneven temperature distribution, and effect of temperature on the physical properties of the material. In this paper the problem is examined by studying the calendering of a viscous liquid in some detail. It is shown that a thermal boundary-layer effect exists of such magnitude as to account for formation of blisters. An example is given using typical calendering dimensions and physical properties of a plastic, which yields a thermal boundary-layer thickness of the order of depth of the blisters as observed. These data furnish further qualitative confirmation to the physical argument.

Fluid Flow Through Porous Metals, by Leon Green, Jr., North American Aviation, Inc., Downey, Calif., and Pol Duwez, California Institute of Technology, Pasadena, Calif. 1950 ASME Semi-Annual Meeting paper No. 50—SA-17 (in type; to be published in the *Journal of Applied Mechanics*).

A METHOD is outlined for correlating experimental data obtained in studies of the flow of gases and liquids through porous metals. The correlation is based upon the suggestion of Forcheimer that the pressure gradient attending the flow of a liquid through a porous medium can be expressed as a function of flow rate by a simple quadratic equation. An equation of this type defines two length parameters necessary for characterization of a porous structure and permits a general definition of the Reynolds number for a structure of arbitrary complexity.

The Uniform Distribution of a Fluid Flowing Through a Perforated Pipe, by Willard M. Dow, Jun. ASME, United Gas Company, Shreveport, La. 1950 ASME Semi-Annual Meeting paper No. 50—SA-14 (in type; to be published in the *Journal of Applied Mechanics*).

A THEORETICAL analysis is made of the flow through a perforated pipe with a closed end for the special case of a constant linear rate of discharge along the length of the pipe. The results of the fluid-flow considerations are applicable to many practical manifold systems. The practical significance of the results with respect to pipe burners for gaseous fuels is emphasized as the results made possible the design of simple high-capacity and extended-range pipe burners of industrial importance. The capacity of commercially available pipe burners may be increased several hundred per cent. The validity of the theoretical results was verified by experiment.

Soap-Film and Sandbed-Mapper Techniques, by A. D. Moore, University of Michigan, Ann Arbor, Mich. 1950 ASME Semi-Annual Meeting paper No. 50—SA-15 (in type; to be published in the *Journal of Applied Mechanics*).

A NEW photographic method for indirect measurement of a soap film is presented. Only one photograph is taken of a spiderweb grid as reflected by the film; the picture is analyzed to find contour lines and lines of maximum slope. Thus the film need last only long enough to be photographed. A fluid mapper of the isolated sandbed type is shown to be an analog for the soap film and, therefore, for the torsional stress situation in a shaft of like boundary. Thus sandbed techniques might replace soap-film techniques. The sandbed mapper also is an analog for other noncircular two-dimensional distributed source situations, such as the following: Field of a space charge; heat flow, with uniform heat production in the volume, the boundary being an isothermal; eddy currents in a plate (or section of lamination) uniformly pierced by a changing flux; magnetic flux in a volume of iron of constant permeability, the iron being (axially) a conductor of uniformly distributed current; streamline fluid flow in a long straight tube (sandbed isopressure lines corresponding to the tube's isovelocity lines); and chemical diffusion, with the diffusing material uniformly appearing or disappearing throughout the volume. Since the sandbed is an analog for the soap film, the soap film is also an analog for these other situations.

Mechanical Dust Collectors

Mechanical Dust Collectors, The Problem and Application, by John T. Doyle, The Thermix Corporation, Greenwich, Conn. 1950 ASME Semi-Annual Meeting paper No. 50—SA-37 (mimeographed).

WITHIN the last decade extensive progress has been made in the art of mechanical dust precipitation.

Prior to the past decade mechanical dust collectors could be placed in three categories: (1) settling chambers; (2) centrifugal collectors, i.e., cinder-collecting fans and large-diameter cyclones; and (3) baffle and impingement-type separators.

Space was perhaps the greatest problem when an attempt was made to install dust-collecting equipment in existing plants and as construction costs increased it became a problem in new plants.

Diameters of collecting elements, however, have been reduced and economically produced for commercial use, to a diameter of $1/2$ in., with substantial increases in efficiency with each reduction in size. Tube diameters of 6 and 9 in. have been available for at least a decade, and within the last five years collectors using tube elements of 3 in. in diam have become an accepted economical fact.

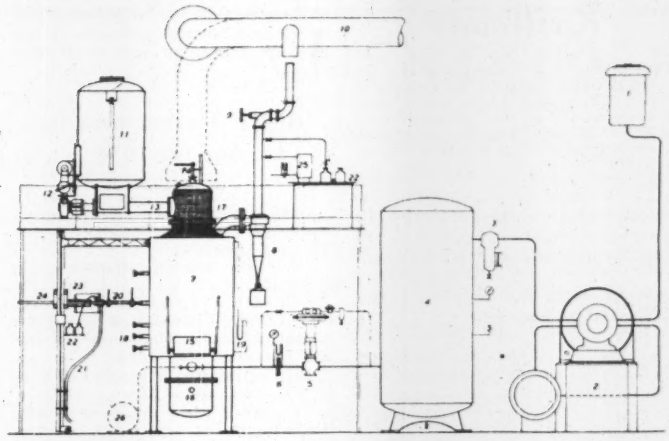
At present several national groups are attempting to write a sample dust ordinance that can be adopted with reasonable assurance of acceptance and standardization by all communities. Among the better known are The American Society of Mechanical Engineers and the Smoke Prevention Association of America. In each case the problem is being attacked on an emission standard basis although the approach is somewhat different. ASME recommendations do not require quite the degree of perfection that the Smoke Prevention Association intends to propose but in the final analysis these differences can be resolved to produce an emission standard that can be enforced. In either case it is economically possible to obtain the equipment necessary for compliance.

Besides fly-ash emission from pulverized-fuel-fired steam generators, spreader, chain and traveling grate, and underfeed stokers are all potential violators under certain conditions of operation. In addition, oil-fired steam generators in some cases also require dust collectors to eliminate a local nuisance condition and many are not equipped and successfully operating with mechanical dust-precipitating devices.

Gas Turbines

Producer Gas for Gas Turbines, by Bruce O. Buckland, Mem. ASME, and Arthur Y. Hillman, Jr., General Electric Company, Schenectady, N. Y., and Harlan W. Nelson, Battelle Memorial Institute, Columbus, Ohio. 1950 ASME Semi-Annual Meeting paper No. 50—SA-33 (mimeographed).

TESTS indicate that a satisfactory overfeed bituminous-coal gas producer can be made to supply fuel to a gas turbine. Rates of coal gasification of 100 to 200 lb per hr per sq ft of grate area can probably be achieved, resulting in a reasonably small producer. The carry-over of solid carbonaceous material in the gas at these rates and at pressures in the neighborhood of 6 atm will be acceptable



SCHEMATIC DRAWING OF FIRST DEVELOPMENTAL GAS PRODUCER AND ASSOCIATED EQUIPMENT

[(1) Intake filter and silencer, (2) air compressor, (3) oil separator, (4) air receiver, (5) pressure regulator, (6) air flowmeter, (7) gasification furnace, (8) cyclone collector, (9) throttle valve, (10) exhaust duct, (11) coal hopper, (12) feed screw drive, (13) coal feed tube, (14) leveling device and indicator, (15) grate-shaking mechanism, (16) ash receiver, (17) top cooling coil, (18) sampling-tube connections, (19) differential manometer, (20) gas-sampling tube, (21) cooling-water lines, (22) gas-sampling bottles, (23) optical pyrometer, (24) sampling tube fixture, (25) dust sampler and filter, (26) starting fan.]

but will be of such a character and amount that separators will be required. The gas stream from which separation is required, however, is a fairly small portion of the total flow of the gas-turbine plant. The gas stream is reducing and will not, therefore, allow separator fires to occur. Thus the separator problem is not unreasonably difficult. The response of the producer to rapid load changes is satisfactory. Only the air rate must change substantially in synchronism with the load. The coal feed, the steam addition to the blast, and the ash-removal rate can follow the load changes with time lags in the order of minutes. The necessary control equipment is simplified by these producer characteristics.

Additional tests could be run profitably in this small producer to explore the tar-condensation problems, and to try out a clinker-grinding variable-speed grate. The problems then remaining should be worked out by means of tests on a full-scale producer.

The tests have indicated that the following features will be required of the producer:

1 A water-cooled wall at least at the oxidation zone to prevent excessive deposit of slag on the retort wall.

2 A substantial coke breaker and stirrer in the top of the fuel to prevent fuel stoppage due to arching of the plastic mass and the coke.

3 A clinker-grinding variable-speed grate with proper control to prevent accumulation of clinker with variable load and with variable ash content of the coal.

Tests have not yet been run to define sufficiently the features required to avoid tar condensation and plugging due to mixtures of tars and solids. Such tests should be run, but it is expected that the make-gas temperature can be maintained high enough to keep the tar in a dry vapor form and still allow a sufficiently wide range of load to be covered.

Gasification under the pressures required by a gas turbine has no detrimental effect on the gas quality and has a beneficial influence on the carry-over. It will require, however, the use of coal- and ash-handling mechanisms with the necessary pressure locks to pressurize the coal stream and depressurize the ash stream. The tests described did not bear on the design problems of such machinery but it is expected that the problems in this design will be no more difficult than those in the design of the producer itself.

A Progress Report on Gas-Turbine Combustors for Pulverized Coal, by Herbert R. Hazard, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio. 1950 ASME Semi-Annual Meeting paper No. 50—SA-41 (mimeographed).

AN important component of a gas turbine utilizing pulverized coal is the combustion chamber, or combustor, in which the coal is burned. The operating conditions under which satisfactory combustion must be maintained include heat-release rates per unit of volume 50 to 100 times those in boiler furnaces, variable static pressure ranging from 30 to 75 psia, and variable air-fuel proportions ranging from 6 to 20 times the stoichiometric ratio.

Full-scale combustors for the pulverized-coal-fired gas turbine under development by the Locomotive Development Committee have been tested at atmospheric pressure, and performance characteristics of several different designs of combustors have been determined. Combustion efficiencies above 90 per cent have been obtained with satisfactory air cooling of the combustor and without ash deposition.

Subsequent experience with the Locomotive Development Committee Houdry gas-turbine unit has demonstrated that combustor performance at 53 psia is better than at atmospheric pressure, and that operation is satisfactory.

Power

Knox Lee Power Plant's Pressurized Boiler—A New Trend in Steam Generation, by J. Robert Welsh, Southwestern Gas and Electric Company, Shreveport, La., and L. Skog, Jr., Jun. ASME, Sargent and Lundy, Chicago, Ill. 1950 ASME Semi-Annual Meeting paper No. 50—SA-40 (mimeographed).

THE Knox Lee Power Plant of the Southwestern Gas and Electric Company consists of two Babcock & Wilcox Company 300,000 lb per hr integral-pressurized furnace boilers and two Westinghouse Electric Corporation 30,000-kw 3600-rpm AIEE-ASME standardized turbine-generator units. The steam-generating units are located outdoors and the turbine-room equipment is enclosed, as well as the operating aisle, in front of the boilers.

The steam-generating units were originally purchased as standard integral-furnace type with forced- and induced-draft fans. During the power-plant development the design was changed so that the furnace and boiler operate under pressure supplied by a forced-draft blower, no induced-draft fans being installed.

The primary objectives for changing the design to pressure operation of the furnace were as follows: (1) An increase in steam-generator efficiency and a reduction in power required for the draft equipment; (2) the elimination of the in-

duced-draft fan and its control equipment; (3) the elimination of the breeching connection as the stack was relocated at the outlet of the air heater; (4) a reduction in the space requirements for the entire steam-generating equipment; and (5) a slight reduction in the capital investment.

The paper discusses the various special features in the design and construction of the plant's steam-generating units. A brief history of the pressurized furnace is reviewed. The advantages of the pressurized-furnace units are outlined, and an investment comparison is made between a standard and a pressurized unit for the power plant. Also discussed are the performance data and operating experiences with this new type of steam-generating unit.

Production

Production Milling of Complex Surfaces by Automatically Controlled Tracing Methods, by M. E. Martellotti, Mem. ASME, The Cincinnati Milling Machine Co., Cincinnati 9, Ohio. 1950 ASME Semi-Annual Meeting paper No. 50—SA-43 (mimeographed).

BASICALLY, the methods for milling complex surfaces can be briefly classified as follows: (1) Use of a milling cutter shaped or formed to the profile to be copied in reverse on the workpiece, and (2) use of a plain or formed milling cutter the path of which is varied automatically, according to the contour wanted.

The contour milling applications which are described in this paper are illustrative of the potential use of and of the contribution made by automatically controlled tracing methods to the production milling of complex surfaces. Contour milling operations which cannot be performed satisfactorily at attractive production rates by ordinary methods are now handled with accuracy and dispatch by tracer-controlled machines in combination with a variety of either special or standard machines and attachments. Integrated revolving tables, reverse-image, automatic scanning, 180 and 360-deg tracer used alone, alternately, or jointly, simplify the arduous process of milling complex surfaces.

The governing economic question in the choice of the contour milling method is still the same as it has been for any machine tool—which will do the job at the rate required with the least possible combination of operating and investment costs for the life of the design for which the part is to be made? The answer increasingly involves one of the two methods described in this paper.

Railroads

Development and Testing of Brakes for High-Speed Railroad Equipment, by Carl E. Tack, Mem. ASME, American Steel Foundries, Chicago, Ill. 1950 ASME Semi-Annual Meeting paper No. 50—SA-20 (mimeographed; to be published in Trans. ASME).

IN the early 1930's, several of the largest railroads of the country started a program to purchase and operate streamlined trains capable of scheduled speeds up to 100 mph which could average 60 mph and more, over distances varying from 1000 to 2400 miles.

Steps were taken by American Steel Foundries to acquire an inertia-type brake-testing machine which would have the increased capacity necessary to test high-speed passenger-car and Diesel-locomotive brakes.

Both safety and economy demand that the utmost care and engineering equipment judgment in brake design be coupled with adequate laboratory tests, followed by road tests, before offering a new brake design to the railroads.

Design work was initiated on improved clasp brakes and several forms of off-the-tread brakes such as drum brakes, multiple-disk brakes, a single-disk brake called the A.S.F. rotor brake, and combinations of some of these.

Trained test engineers were assigned to observe and record with proper instruments the operating conditions encountered on several large railroads in the East and in the West. The information thus obtained was used as a guide in determining laboratory and road-test procedure. It was also used to enable the designer to determine other requirements.

Studies were made to determine the effect of weather—particularly icing conditions—on brake performance. Also studied were railroad maintenance techniques which were found to vary widely. Operating techniques were found to differ greatly from one territory to another.

It further became apparent that the railroad brake problem must be studied as a whole. The air-brake-control apparatus, the foundation brake gear, and the friction shoe must be tested in such a manner that the proper relationship of these three is maintained. Since no laboratory facilities existed for the simultaneous testing of the completely integrated brake mechanism, the American Steel Foundries Brake Testing Machine was designed to enable such tests to be made.

It is equipped with complete instrumentation to measure torque, stop distance, stop time, and forces in the brake mechanism, as well as the performance of the air-brake control apparatus. It can test all designs of railroad friction brakes.

ASME Transactions for August, 1950

THE August, 1950, issue of the Transactions of the ASME contains the following:

TECHNICAL PAPERS

Zero-Pressure Thermodynamic Properties of Some Monatomic Gases, by J. A. Goff, Serge Gratch, and S. W. Van Voorhis. (49—A-145)

Zero-Pressure Thermodynamic Properties of Carbon Monoxide and Nitrogen, by J. A. Goff and Serge Gratch. (49—A-50)

The Thermodynamic Properties of Helium, by S. W. Akin. (49—A-96)

Some New Values of the Second Enthalpy Coefficient for Dry Air, by J. R. Andersen. (49—A-40)

New Measurements of the Heat Conductivity of Steam and Nitrogen, by F. G. Keyes and D. J. Sandell, Jr. (49—A-43)

Compilation of Thermal Properties of Wind-Tunnel and Jet-Engine Gases at the National Bureau of Standards, by Harold J. Hoge. (49—A-86)

Pressure-Volume-Temperature Relationships of Gaseous Normal Hydrogen From Its Boiling Point to Room Temperature and From 0-200 Atmospheres, by H. L. Johnston and David White. (49—A-149)

Heat Transfer to a Fluid Flowing Turbulently Between Parallel Walls With Asymmetric Wall Temperatures, by R. A. Seban. (49—A-18)

Heat-Transfer Rates in Centrifugal Compressors and the Effect of Internal Liquid Cooling on Performance, by W. E. Trumpler, R. W. Frederick, and P. R. Trumpler. (49—A-93)

The Hydrodynamic Lubrication of Cyclically Loaded Bearings, by E. M. Simons. (49—A-41)

The Mechanism of Lubrication Failure in High-Speed Ball Bearings, by F. C. Jones and D. F. Wilcock. (49—A-36)

Turbulence in High-Speed Journal Bearings, by D. F. Wilcock. (49—A-37)

Closed-Cycle Gas Turbine, by Curt Keller. (49—A-35)

A Pyrometer for Measuring Total Temperature in Low-Density Gas Streams, by Sidney Allen and J. R. Hamm. (49—A-66)

Heat Transfer From an Air Jet to a Plane Plate With Entrainment of Water Vapor From the Environment, by Max Jakob, R. L. Rose, and Maurice Spielman. (49—A-16)

Pressure Drop and Convective Heat Transfer With Surface Boiling at High Heat Flux; Data for Aniline and n-Butyl Alcohol, by Frank Kreith and Martin Summerfield. (49—A-94)

Heat Transfer and Fluid Friction During Viscous Flow Across Banks of Tubes—III, by O. P. Bergelin, G. A. Brown, H. L. Hull, and F. W. Sullivan. (49—A-87)

Experimental Evaluation of Human Shape Factors With Respect to Floor Areas, by F. W. Hutchinson. (50—S-4)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Leadership in Management

COMMENT BY IVOR LUSTY[1]

The 1949 Towne lecture[2] is a light of inspiration to management everywhere. The author's assessment of management's responsibilities to man is succinct and full. However, his review, in horror of the great social experiments taking place in England today, is hardly in keeping with the width of his vision. Surely, to an engineer, this is a pilot production worthy of study, not out-of-hand rejection. Let us profit by their successes, if any, as well as by their mistakes. Let us note that their present predicament springs from 40 years of overspending (coupled with two very expensive wars), and that their present objective is the very laudable one of balancing the budget. Will our orgy of overspending bring us to the same position when, according to all current indications, we would be faced with a less charitable neighbor than England has had in us?

Democratic progress is a vector; it has direction and velocity. The direction has not changed appreciably in the past 400 years. Democracy has earned for its participants the right of personal freedom, the right to own property, the right to associate with fellow thinkers and to express one's opinions freely, the right to worship how one chooses, the right to vote, the right to a free education, and the right not to die of starvation. The trend now is to extend these rights to include the right to a dietary sufficiency, the right to a minimum standard of shelter, and the right to share the benefits of the world's knowledge of preventive and curative medicine.

The velocity of the vector, however, has changed, and it is in this field that the best judgments of management should be applied, for, when the rate of change along this vector is not matched by developments in our constitutional maturity, the planners step in with all manner of restrictive legislation in an effort to make things work. Thus may we lose our liberty.

Management is a critical function. We must be influenced in our judgments by our experiences, and beware of the biased writings which flood our press today. We must assess critically our velocity along the vector of democratic development to insure that we do not overstep by too great a margin the mass mental adjustment which its operation requires.

New Zealand may be considered the laboratory, England the pilot production. Both merit the closest study, firsthand if possible. Management, which has such an influential part to play in American social development, must evaluate the recent election results in these countries. Do we see a significant change in direction or only in velocity?

AUTHOR'S CLOSURE

Mr. Lusty asks us to note that the "present objective" of the Labor Government "is the very laudable one of balancing the budget," as if this were and always had been its primary objective. Of course it is no such thing. Labor's health scheme, the nationalization of industry, and the sundry other plans which the Party espouses for spending the people's money more wisely than the people could spend it for themselves leave little doubt that the problem of budget balancing has penetrated Labor's consciousness, alas, too little and somewhat too late. Substantially the only contributions which the Labor Government has made to budget balancing have been of a negative character—a schedule of almost confiscatory taxation and a regimen of drab and uninspiring austerity, which in combination have robbed British commerce and industry of virtually all incentive for providing the wherewithal for balancing the budget.

One further comment: In compiling a catalog of human rights, one would do well to distinguish between those which are inherent and those which must be earned. There is a vast difference between the rights of free speech and worship, for example, and the right to own property. The first are inherent; the second exists only if you earn it. Mr. Lusty would extend human rights to include the right to a dietary sufficiency, a minimum standard of shelter, and (by implication) medical care. All of these, in my judgment, belong in the second category rather than the first. They must be acquired by work and effort, homely virtues which seem to be losing the respect which they once enjoyed. How about compiling a catalog of human obligations, which might be summed up in the words of the late Fra Elbertus, "The man who never does any more than he gets paid for never gets paid for any more than he does."

FREDERICK S. BLACKALL, JR.[3]

[1] Seattle Wash. Mem. ASME.

[2] "The Obligation of Management to Provide Leadership," by F. S. Blackall, jr., MECHANICAL ENGINEERING, vol. 72, March, 1950, pp. 229–231.

[3] President and Treasurer, The Taft-Peirce Manufacturing Co., Woonsocket, R. I. Fellow ASME.

Progress in Railway Mechanical Engineering

COMMENT BY SIDNEY WITHINGTON[4]

The report[5] each year of the Railroad Committee contributes invaluable data for historians who may, in the future, review railroad progress. The current report maintains the high level of previous committee reports in this connection, and as a matter of record is exceedingly valuable.

The problems, not only in mechanical engineering but also in the fields of electrical and civil engineering, are of increasing importance with the rising costs of labor and material, and especially just now in connection with the 40-hr

[4] Engineering Assistant to Executive Vice-President, The New York, New Haven and Hartford Railroad Company, New Haven, Conn. Mem. ASME.

[5] "Progress in Railway Mechanical Engineering, 1948–1949," MECHANICAL ENGINEERING, vol. 72, April, 1950, pp. 303–315.

week which was applied recently to railroads.

It would add to the value of the report if such items as track-maintenance machines (ballast-cleaning, tie-tamping, and the like) were discussed. There has been considerable development in this respect recently, and the machines are the products of mechanical engineers.

Other items such as pneumatic tubes in freight yards, material handling in freight houses, locomotive and car shops, and so forth, some of which are discussed elsewhere, might be mentioned in this report to complete the record.

The design of Diesel locomotive shops, including the salient features of the somewhat different requirements as compared to steam-locomotive maintenance, might be mentioned to advantage.

Other mechanical-engineering matters would include mobile snow melters for passenger and freight-yard tracks, snow melters for freight platforms, mobile ice plants for icing cars, etc., all of which have been developed in the field of mechanical engineering.

Another item of great interest to railroad people is accounting machines which are becoming of vital importance in compiling and maintaining records of all kinds on railroads and which are largely in the field of mechanical engineering.

Mention also might be made of 50-cycle single-phase traction power distribution, which recently has been suggested in connection with European electrification and may be of considerable importance in this country. Utilization of our standard commercial 60-cycle frequency without change in this country would have many obvious advantages.

A unit of motive power which, as a matter of record, should be included in this year's report, is the mercury-arc-rectifier car now on test on one of our leading railroads. The advantages of this car may well be associated with the development of the use of 60-cycle power distribution in the trolley, as just indicated, and, thus, be of importance in a broad sense as well as in the features of the unit itself.

COMMITTEE CLOSURE

Unless the scope of coverage of such a report as that prepared annually by the committee on Survey RR-6 of the ASME Railroad Division is delimited, it is quite difficult to determine where to stop.

In general, the field covered is that in which members of the Railroad Division are primarily and principally interested. This seems to be on subjects having to do with rolling stock—cars and motive power.

Maintenance-of-way machines are primarily in the province of the civil engineer, and the American Railway Engineering Association reports on these items. Shops and terminals are also a concern of this group.

Materials handling is a subject of interest to some of the railroad mechanical-engineering fraternity, but the subject as a whole is properly allocated to the Materials Handling Division of the Society.

Accounting machines are not peculiarly "railroad machines" and while many are used by the railroads, reportorial treatment is more properly assigned to other specifically interested groups.

There are several 50-cycle electric locomotives under construction in Europe and when data on these are secured, they will be covered in future issues of the report.

The mercury-arc-rectifier car mentioned by Mr. Withington is covered by the report under "Projected Motive-Power Developments." At the time the report was prepared and closed, the car had not been placed in operation.

T. F. PERKINSON.[6]

[6] Chairman, Committee RR-6, and Manager, Transportation Engineering Division, General Electric Company, Schenectady, N. Y. Mem. ASME.

Lantern Slides

TO THE EDITOR:

What you say editorially concerning lantern slides[7] is, of course, 100 per cent correct. It is surprising how little care is applied even for slides which are used over and over by companies when they are sending their engineers around to advertise a certain product.

There should be a standard for lantern slides, possibly not only for the slide, but for the original drawing, giving a frame with some lettering, for Society papers, "ASME" for example.

Color slides are very helpful. They can be made at very little cost by coloring the original with colored crayons and taking pictures on Kodachrome film which are processed in the usual way.

With slightly more expense, but still not too high, the originals for such color slides, on standard-size white paper, could be sent to one studio specializing in color slides for industry. This is still much less expensive than the procedure which was used in Germany (VDI Standard) to make a negative with white lines on black background and color the lines with ink by hand.

There is another very important point: The room should never be completely dark, a low level of illumination should remain so that the audience can make notes; 99 per cent of all slide pictures are so bright that a little light in the meeting room does no harm.

The "standard slide design" could be printed in the booklet, "An ASME Paper," and in ASA Z 15.3–1947. To the latter the writer would add one suggestion: In logarithmic scales (Fig 11), the lines for "1" and "5" should be heavier than all the others. This makes it much easier to take values from a diagram.

GEORGE KEINATH.[8]

[7] An editorial, published in MECHANICAL ENGINEERING, vol. 72, June, 1950, p. 454.

[8] Consulting Engineer, Larchmont, N. Y. Mem. ASME.

Correction to Paper

ATTENTION is called to an error appearing in the paper, "Vibration of a Cantilever Beam With Prescribed End Motion," by G. A. Nothmann, as published in the *Journal of Applied Mechanics* for December, 1948, pages 327–334.

Because of an inadvertent algebraic error, the sign preceding the summation sign in Equation [7], problem A was minus instead of plus. Later relations based on this Equation are likewise in error. The corrected curves, Figs. 5 through 8, for "End Force Versus Time" are identical to those of the paper as published except that the "wave components" are reversed. As a result, the discontinuities which are exhibited by the composite curves disappear. The conclusions remain correct as stated.

Copies of the corrected Equations and Figs. 5 through 8 may be obtained by writing to the author. This error was called to the writer's attention by Messrs. N. M. Newmark, L. E. Goodman, and Z. K. Lee of Champaign, Ill., whose co-operation is gratefully acknowledged.

G. A. NOTHMANN.[9]

[9] 5968 West Erie St., Chicago 44, Ill.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Steam Turbines and Their Cycles

STEAM TURBINES AND THEIR CYCLES. By J. Kenneth Salisbury. John Wiley and Sons, Inc., New York, N. Y., Chapman and Hall, Ltd., London, England, 1950. Cloth, 5¾ × 9 in., illus. figures, tables, Exercises, Appendix, Bibliography, Index, xvi and 645 pp., $9.

REVIEWED BY J. M. LABBERTON[1]

THIS is an excellent book written by a competent author who has much practical turbine experience. He has been with the General Electric Company for twenty years, mostly in turbine work, and is at present division engineer of the thermal power systems division of that company.

It is a book no one interested in or responsible for the design, application, or purchase of large turbines should be without—and this includes the marine field. The book is concerned mostly with the steam design and thermodynamic aspects of the steam turbine rather than with the mechanical or "machine" design, less than five per cent of the volume being occupied with descriptions of turbines, governor mechanisms, bearings, etc.

However, it is extremely practical, containing a vast amount of data on losses, reheat, and design methods by means of which any intelligent engineer can design a stage or a complete turbine and predict its performance accurately.

The book is replete with curves and tables, condensing and making available the results of hundreds of tests on turbines and plants. The theory and reasoning back of these data as well as the method of using are thoroughly and clearly explained with little excess verbiage. The part on steam-path design is typical of the whole book, covering the choice of the major elements, the design of the first stage, and the assignment of energy to the following stages.

The regenerative cycle is covered thoroughly including full instructions for making a heat balance by both the conventional methods and by means of an accurate short cut devised by the author. Of great value are factors given for estimating extracted steam at the various stages for the preliminary or trial heat balance. Conventional heat balance being a cut-and-try process anyway, the more accurate the first cut, the sooner the job is done. Methods for calculating heater-cycle losses for various arrangements involving different types of heaters are given.

Data and methods for estimating steam rates for various throttle and exhaust conditions and corrections therefor are given in detail for any deviations from the normal conditions and for partial loads.

The gas turbine and the reheat cycle are touched very lightly in this book and anyone interested in these subjects should look elsewhere.

But for steam turbines and the regenerative cycle in all its aspects, not a finer, more clearly presented lot of what would ordinarily be confidential information has been presented to the public for many years. It is a most useful, clear, complete, and practical book written in simple language.

As to the value of this book as a college text, it is probably too detailed and intricate for use by undergraduates in view of the short time now permitted to a specialized subject such as turbines.

Also, the preparation the undergraduate would have at the time he would encounter this subject would be insufficient to properly grasp the content of this book. But for a graduate course in turbines and cycles, it would be an excellent text.

[1] Consulting Engineer, Professor of Marine Engineering, New York University, New York, N. Y. Mem. ASME.

Steam Power

DAMPFKRAFT. By Friedrich Münzinger. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1949. Third edition. Printed in German language. Paper, 7½ × 11 in., 859 figures, 62 rm., 76 tables in text, 19 suppl. tables, xii and 546 pp., dm 82.50; bound, dm 87.50.

THIS is a third edition of "Berechnung und Verhalten von Wasserrohrkesseln," previously published in 1929 and 1933.

Some chapters are unaltered from the second edition; some are revised, and an entirely new chapter added which deals with the possible future development of power generation from atomic energy. As a whole, the new revision is not so well done as the 1933 edition.

Dealing first with the chapters on heat transfer, draft losses, and performance of boiler units (3 to 5), pages 52 to 231, it appears that while the principles of approach have been carried over from the earlier editions, a good many items, and in particular the working charts, have been brought up to date in line with the research results available to the author and published after the 1933 edition was brought out. Throughout his publications Münzinger has made it quite clear on whose original work or publications his working charts dealing with heat transfer, fluid flow, etc., have been based, and that all he claimed to have done in this connection was to put everything into a consistent shape to use—at least for the continental user of the book, who is accustomed to work to the Nm^3, i.e., lm^3 at 760 mm Hg and 0 deg C as unit of quantity, and to gas and air speeds in m per sec. (The use of the unit weight as unit of quantity for gas and air practically came to an end on the European continent when Münzinger published in his 1929 book, working charts for the determination of gas and air quantities solely as functions of net calorific value and excess air. Later publications by Rosin and others did more to make the working to Nm^3 quite universal on the continent. Mass flows instead of velocities are quite unknown in metric countries.)

In the new edition specific heats have been based on spectroscopic data—neglecting the heat of dissociation; heat transfer and flow across tube banks have been based on the results of Grimison and his co-workers; nonluminous radiation has been based on German and United States research workers' publications, so it might be safely stated that the working charts attached to the latest edition have

been modified to fall in line with considerable of the latest research. The charts on furnace temperatures based on Wohlenberg and others are practically useless because of the use of optical or calculated temperatures.

In connection with these theoretical chapters, insufficient emphasis has been laid on the necessity of adjusting any calculations based on theoretical data for the influence of the cleanliness of heating surfaces, although there are some paragraphs pointing out the lowering of heat transfer due to heating surfaces becoming dirty.

The influence of certain variations in design or operating conditions on the over-all performance of boiler units (chapter 5), is illustrated in an interesting manner, although about 80 per cent of the figures and text are identical with the 1929 edition.

The general chapters on the historical development of the transformation of chemical heat in fuels into mechanical energy make good reading.

The descriptive chapters are the weakest sections, and naturally are mainly based on German practice, giving very little beyond what was contained in the 1933 edition.

The complete lack of dealing in a comprehensive manner with the later developments in the U. S. A. and Britain must be attributed to the difficulties the author had in obtaining during the period of 1939–1948, publications from the English speaking world, other than those secured by chance. Great advances were made in American boiler design during this period. No mention has been made of steam scrubbers in their present form, of steam cyclones, or of other new developments in the new edition.

The final chapter on atomic energy (pages 519–537), attempts to tackle these problems in a similar way as the other problems of steam-power generation have been treated in this book—on a partly technical, partly economic basis. The author succeeds in putting the main problems over to the average reader in such a way that he should, without any specialized knowledge, be able to understand them. It can be taken for certain that Münzinger has not had anything in connection with atomic energy at his disposal other than the references quoted from pages 519 and 530, and wherever personal opinions or speculations come into the picture they have been clearly marked as such.

As a whole, the book would have been better if it had been written one or two years later, so that there might have been the chance of incorporating the latest practice of Western German, English, and American boiler design.

Forest Products

FOREST PRODUCTS: Their Sources, Production, and Utilization. By A. J. Panshin, E. S. Harrar, W. S. Baker, and P. B. Proctor. McGraw-Hill Book Co., New York, N. Y., 1950. Cloth, 6¼ × 9¼ in., tables, illus., charts, diagrams, figures, maps, plate, Index, Bibliography, ix and 549 pp., $6.

REVIEWED BY A. Z. NELSON[1]

THE authors have presented in this text on forest products essentially a comprehensive review of the present-day manufacture and use of wood in its many forms. They are all well-recognized experts in this field.

In 11 chapters and 230 pages they have covered such subjects as poles, piles, posts, mine timbers, railroad ties, furniture, veneers and plywood, barrels, tanks and vats, wood boxes, crates and baskets, shingles and shakes, wood flour, sawdust and shavings, wood fuel including charcoal and producer gas, lead pencils, matches, toothpicks, and excelsior.

In the five chapters and 129 pages that follow, they discuss the manufacture of pulp and paper, starting with the pulpwood log and carrying the process through its various stages and systems to the finished product; they discuss thermal and sound-insulating materials such as building board, lath, roof insulation board, interior board, sheathing and panels; they discuss the manufacture and use of wood for rayon, cellophane, photographic films, artificial sponges, sausage casings, and lacquers; they discuss the manufacture of charcoal and the distillation of wood to form such products as acetic acid, acetone, methanol, tar oils, pitch, turpentine and dipentene; and they discuss wood "saccharification" or the hydrolysis of wood to produce sugar, molasses, ethyl alcohol, and yeast.

No less interesting are the final five chapters and 110 pages. In them the authors discuss naval stores, maple syrup and sugar, tannins and dyes, wood plastics, medicinal and insecticidal products, cork, and even fiber for clothing.

In chapter three the authors state that "wood is strong for its weight, and when dry and free from defects, pound for pound it compares quite favorably in strength with steel and other structural materials." They also say that "wood neither crystallizes nor becomes brittle, like metals, nor loses its cohesive characteristics, like concrete, when subjected to low temperatures"; and "wood generally gives warning before it fails, a fact of prime importance in various structural members, such as bridge and mine timbers."

But they also point out that wood for structural purposes cannot be extended or rolled into new shapes; its moisture content varies; it decays, although the life of wood can be prolonged by treating with preservatives; and wood burns, although in doing so it loses its strength gradually.

In 1844, the authors tell us, was established the first commercial telegraph system—a line 40 miles in length extending from Washington, D. C. to Baltimore, Md. The wires were strung on wood poles, and thus began a new forest-products industry, pole production. In the discussion that follows the authors have included the American Standard Specification and Dimensions for Southern Pine Poles, approved by the American Standards Association. This is illustrative of much material in the text of direct value to the engineer.

The text is well illustrated with photographs, charts, and drawings. Each chapter is followed by a carefully selected list of references. A 23-page index is included.

To the reviewer there appear to be two deficiencies in the text—of major or minor importance depending upon one's personal interest. First, there is only very general discussion of lumber as a forest product—yet lumber is the most important forest product of all. Inclusion of a chapter on lumber would have provided a more comprehensive and better-balanced volume.

Second, inclusion of a chapter on forest-products research would have been worth while. Great strides are being made in this field by the United States Forest Products Laboratory at Madison, Wis.; the Timber Engineering Company at Washington, D. C. (affiliated with the National Lumber Manufacturers Association); by other industry organizations and private corporations; and by the colleges and universities. Although such research is discussed to some extent in various places in the text, a concise and up-to-date review of just what is being done is not obtainable.

This text, which is published as part of the "American Forestry Series," is by no means the only book available on this subject. In the reviewer's opinion, however, in many respects it ranks among the best.

[1] Forest Consultant, National Lumber Manufacturers Association.

Books Received in Library

DATA BOOK ON HYDROCARBONS, Application to Process Engineering. By J. B. Maxwell. D. Van Nostrand Co., Inc., New York, N. Y.; London, England; Toronto, Canada, 1950. Cloth, 7 × 10¼ in., 259 pp., charts, tables, $5. This book presents data on the molecular weight, vapor pressure, fugacity, critical and thermal properties, density, viscosity, and combustion of hydrocarbons. It also includes methods of applying this information to a few of the unit operations of chemical engineering which are used in the petroleum industry. Data are mainly present in the form of graphs and nomograms. Tables of physical constants are also included.

DAVISON'S RAYON AND SILK TRADES including Nylon and Other Synthetic Textiles, The Standard GUIDE, 55th Annual Pocket Edition, 1950. Davison Publishing Co., Ridgewood, New Jersey. Cloth, 5 × 7½ in., 511 pp., illus., charts, tables, maps, $5.50 ($7.50, deluxe office edition). This annual index reports on rayon, nylon, other synthetics, and silk manufacturers; yarn manufacturers, throwsters, dyers, finishers, printers, sanforizers; agents, brokers, factors, importers, converters; New York offices and salesrooms of mills; dealers in raw silk, thrown and spun silk, rayon, and nylon; waste and yarns. A classified directory by products is included as well as statistical tables, a technical compendium of yarn tables, and a complete alphabetical mill index.

DIAMOND TOOL PATENTS IIIs, TRUING OF GRINDING WHEELS, Supplement 1949, by W. Jacobsohn. Industrial Diamond Information Bureau, Industrial Distributors (Sales) Ltd., London, EC1, England, 1949. Paper, 7¼ × 9½ in., 45 pp., diagrams, tables, 7s6d. This is a supplement to a recent survey which contained relevant British, American, and German patents issued from 1916 to 1946. It considers patents issued in 1947 and 1948 and also some which were issued prior to this period and not included in the earlier survey. Some French, Australian, Swiss, and Canadian patents are also abstracted although the patent literature of these countries is not exhaustively dealt with.

ENGINEERING PRECISION MEASUREMENTS. By A. W. Judge. Second edition, revised, Chapman & Hall Ltd., London, WC2, England, 1950. Cloth, 5½ × 9¾ in., 363 pp., illus., diagrams, charts, tables, 30s. This book provides a general survey of the more important methods of precision measurements employed in the engineering workshops, and describes in detail some of the more widely used ones from the viewpoint of the user in the gageroom, inspection department, toolroom, and machine shop. For some cases the principles of the methods upon which the instrument is based are given and typical examples are described. An abridged account of the more important recent advances in this field is also included.

KENT'S MECHANICAL ENGINEERS' HANDBOOK. (Wiley Engineering Handbook Series.) Vol. 1. Design and Production Volume, edited by C. Carmichael. Vol. 2. Power Volume, edited by J. K. Salisbury. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England. Twelfth edition, paged in sections, 1950. Leather, 5½ × 8½ in., illus., diagrams, charts, tables, $8.50 per volume. Volume 1 now primarily directed toward the engineers who design and manufacture machinery, appliances, mechanical equipment, and other engineered products, this edition provides a summary of the essentials of the field together with pertinent data. The six main sections cover selection of materials, design principles, design and selection of machine components, production processes, production-plant equipment, and mathematical tables. References are included in the text and at the ends of many of the chapters. Volume 2, thoroughly revised and rewritten, covers the entire field of heat-power engineering and transportation as well as the important aspects of fluid flow. The first four sections treat power processes. The service functions, pumping and piping, are dealt with in the next two sections. Power-producing equipment, refrigeration, heating, ventilating, air conditioning, transportation, and electric power are then discussed. The remaining sections are devoted to atomic energy, instrumentation, power-test codes, and mathematical tables.

PLANT LAYOUT AND MATERIALS HANDLING. By J. M. Apple. Ronald Press Co., New York, N. Y., 1950. Cloth, 6¼ × 9¼ in., 367 pp., illus., diagrams, charts, maps, tables, $5. Presented from an engineering standpoint, this book shows how to develop the most efficient layouts of equipment and of operating and service facilities for manufacturing plants, warehouses, and other industrial or business applications. Emphasis is on the major problem of essential co-ordination between plant layout, materials handling, methods engineering, production planning, and control. A bibliography and many illustrations are included.

SUPERSONIC AERODYNAMICS, a Theoretical Introduction. By E. R. C. Miles. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Linen, 6 × 9¼ in., 255 pp., diagrams, charts, tables, $4. Beginning with the fundamental thermodynamics and a discussion of the divergence theorem, this text continues with a mathematical treatment of various types of flow. Shock phenomena are covered, and a detailed exposition is given of the graphical-computational method of characteristics for axially symmetric supersonic flow. Suitable for any reader having some acquaintance with fluid dynamics, the book is intended to provide a background for further theoretical investigation and for the understanding of current professional literature.

SYMPOSIUM ON TESTING OF CAST IRON WITH SR-4 TYPE OF GAGE, (Special Technical Publication No. 97) presented at the Fifty-Second Annual Meeting, American Society for Testing Materials, Atlantic City, N. J., June 29, 1949. Paper, 6 × 9 in., 92 pp., illus., diagrams, charts, tables, $1.65. This symposium covers the analysis of stresses in automotive cylinder blocks; the strain testing of machine parts; strain-gage tests on Diesel cylinder blocks, heads and pistons; and stress-strain testing of cast-iron machine parts particularly for textile machinery, railroad service, and tractors.

TABLE OF POWERS OF COMPLEX NUMBERS. (National Bureau of Standards, Applied Mathematics, Series 8.) By H. E. Salzer. For sale by Superintendent of Documents, Government Printing Office, Washington 25, D. C., 1950. Paper, 8 × 10½ in., 44 pp., tables, $.25. The present tables give the exact values of z^n for $z = x + iy$ where x and y each range from 0 through 10 at unit intervals, and where $n = 1, 2, \ldots\ldots 25$. Also included is a table giving the values of x^n for $x = 2$ to 9 and $n = 1$ to 25, both at unit intervals.

VECTOR AND TENSOR ANALYSIS. By H. Lass. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × 9¼ in., 347 pp., diagrams, tables, $4.50. Offering a unified approach to the subject in its relationship to theoretical physics, this text acquaints the reader with the methods and tools of vector and tensor analysis as applied to geometry, mechanics, electricity, hydrodynamics, and the theory of relativity. It includes chapters on the algebra of vectors and the differential and integral calculus of vectors. A knowledge of the calculus is assumed. Worked and unworked examples are included.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) At the succeeding Board meeting they are acted upon; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING. The following Case Interpretations were formulated at the Committee meeting June 23, 1950 and approved at the Board meeting August 9, 1950.

CASE NO. 941 (*Reopened*)

In Par. (2) of the reply the allowable stress is given as 18,000 psi, based on a factor of safety of five. This is to be increased to 25,000 psi, based on a factor of safety of four.

CASE NO. 1056 (*Reopened*)

In the last sentence of the inquiry, where the allowable stresses for temperatures not exceeding 650 F are given as 15,000 psi for Grade A and 14,600 psi

for Grade B, both corresponding to a factor of safety of five, the Grade A should be increased to 18,750 psi and the Grade B to 18,250 psi, both corresponding to a factor of safety of four.

CASE No. 1091 (*Reopened*)

In Par. (1) of the reply the reference to alloy CS41 of ASTM Specification SB211-48T, should be changed to alloy CS41A of ASTM Specification B-211-49T.

CASE No. 1099 (*Reopened*)

In the reply the reference to ASTM B139-48T should be changed to ASTM B139-49T.

CASE No. 1111

(*Interpretation of Par. UW-10*)

Inquiry: Par. UW-10 requires thermal stress relieving when the thickness of the plate or vessel wall exceeds certain limits. In the manufacture of refrigeration condensers, a plate is used as a tube sheet. May the thickness of the tube sheet exceed the limitation given for the shell and be welded to the shell of the vessel without this requirement for thermal stress relieving?

Reply: It is the opinion of the Committee that the welds joining a tube sheet to a shell need not be stress relieved unless Par. UW-10 requires stress relieving of the shell itself, or unless the shell would be required to be stress relieved if made of the same material as the tube sheet.

CASE No. 1113

Inquiry: Is it permissible under the Code to use alloy steel staybolt materials having the following chemical composition and tensile properties in lieu of the carbon steel staybolt material now provided in Specification SA-31? If so, what maximum allowable stresses shall be used?

Chemical Composition

carbon, max per cent	0.10
manganese, max per cent	0.40
phosphorus, max per cent	0.04
sulphur, max per cent	0.04
silicon, max per cent	0.20
other elements,	sufficient to develop specified tensile properties in the as rolled or cold drawn and normalized condition.

Tensile Properties

tensile strength, psi	50,000 to 60,000
yield point, min psi	33,000
elongation in 8 in. min	30%
reduction in area, min	62%

Reply: It is the opinion of the Committee that material as defined in the Inquiry may be used according to the existing rules covering staybolts.

CASE No. 1115

Inquiry: Is it permissible under the requirements of Section I and Section VIII of the Code to use austenitic stainless steel castings complying with the requirements of ASTM Specification A-296-49T, Grades CF-8, CF-20, CF-8M and CF-8C, and if so, what allowable working stresses may be used?

Reply: It is the opinion of the Committee that austenitic stainless steel casting complying to the chemical requirements of ASTM Specification A-296-49T, Grades CF-8, CF-20, CF-8M and CF-8C but otherwise complying to the requirements of Specification SA-157 Grade C9, may be used under the applicable requirements of Section I and Section VIII of the Code.

The maximum allowable working stresses for Grades CF-8, CF-20 and CF-8C shall be the same as now given in Tables P-7 and U-2 for Grade C9 of SA-157.

The maximum allowable working stresses for Grades CF-8M shall be the same as now given in Tables P-7 and U-2 for Grade C9 of SA-157 at temperatures up to and including 900 F; at 950 F and above the values shall be the same as for grade M of SA-240.

Cases Annulled

The following Cases have been annulled: Nos. 824, 1026, and 1050. [Reannulment of Case 1050, see Par. P-186(f) under Revisions]

Proposed Revisions and Addenda to Boiler Construction Code

As need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [ ]. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

PAR. P-186(f) Add at end:

As an alternate method of determining the maximum allowable loading on structural attachments to tubes, see Par. A-73(b) for conducting tests on full size sections of tubes.

PAR. A-73 (in the Appendix) Make this paragraph A-73(a) and add as A-73(b):

A-73(b) To determine the maximum allowable loading on structural attachments to tubes, a test may be conducted on a full size section of tube with attachment. The test may be considered as meeting the Code requirements provided:

(1) The loading applied to the test specimen is at least equivalent to the design loading, and at the same time the tube is subjected to a hydrostatic pressure corresponding to design conditions.

(2) The test is conducted in accordance with the requirements of Pars. A-22 to A-32 with the exception that the hydrostatic pressure be held at expected design pressure, and the loading on the support be increased until permanent set occurs.

(3) The maximum load P, allowed on the attachment at or below the pressure corresponding to the hydrostatic pressure is given by the following formula:

$$P = \frac{HS}{E}$$

where

P = Maximum allowable load on attachment—pounds
H = Test load at the proportional limit of the structure—pounds
S = Working stress permitted in Table P-7 for the tube material at the expected operating temperature which in no case shall be taken at less than 750 F—pounds per sq. inch.
E = Average proportional limit of the tube material—pounds per sq. inch.

FIG. P-21 Substitute the following for sketch (f).

PAR. P-198(a) Revise fifth definition for C to read:

C = 0.50 for plates fusion welded to the inside of [pipes or headers] A VESSEL and otherwise meeting the requirements for THE RESPECTIVE TYPES OF fusion-welded [boiler drums] VESSELS, including stress relieving WHEN REQUIRED FOR THE VESSEL but omitting radiographic examination, [and where the plate is welded for its entire thickness] WHERE THE WELD HAS A THROAT DIMENSION EQUAL TO TWO TIMES THE REQUIRED THICKNESS OF A SEAMLESS SHELL, BUT NOT GREATER THAN THE HEAD THICKNESS NOR IN ANY CASE LESS THAN 1.25 TIMES THE ACTUAL SHELL THICKNESS, AND WHERE THE WELD IS DEPOSITED IN A WELDING GROOVE WITH THE ROOT OF THE WELD

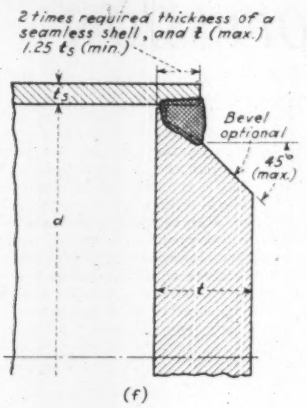


FIG. P-21 SKETCH (*f*)

AT THE INNER FACE OF THE HEAD, AS SHOWN in Fig. P-21(f) [with a fillet weld having a throat not less than $1^1/_4$ times the thickness of shell or flat head, whichever is smaller,]. BEVELING OF THE REMAINDER OF THE HEAD PLATE TO AN ANGLE NOT EXCEEDING 45 DEG IS OPTIONAL.

Low-Pressure Heating Boilers 1949

PAR. H-64(a) Revise to read:

H-64 *Automatic Low-Water Fuel Cutoff and/or Water-Feeding Device* (a) [It is recommended that all] EACH automatically fired steam or vapor-system boiler [s] SHALL be equipped with an automatic low-water fuel cutoff [and/or water-feeding device so constructed that the water inlet valve cannot feed water into the float chamber, and] so located as to automatically cut off the fuel supply [and/or supply requisite feed water] when the surface of the water falls to the lowest safe water line. [This point should be not lower than the bottom of the water glass.] IF A WATER-FEEDING DEVICE IS INSTALLED, IT SHALL BE SO CONSTRUCTED THAT THE WATER INLET VALVE CANNOT FEED WATER INTO THE BOILER THROUGH THE FLOAT CHAMBER AND SO LOCATED AS TO SUPPLY REQUISITE FEEDWATER. THE LOWEST SAFE WATER LINE SHOULD BE NOT LOWER THAN THE LOWEST VISIBLE PART OF THE WATER GLASS.

PAR. H-117(a) Revise to read:

H-117 *Automatic Low-Water Fuel Cutoff and/or Water-Feeding Device* (a) [It is recommended that all] EACH automatically fired steam or vapor-system boiler [s] SHALL be equipped with an automatic low-water fuel cutoff [and/or water-feeding device so constructed that the water inlet valve cannot feed water into the float chamber, and] so located as to automatically cut off the fuel supply [and/or supply requisite feedwater] when the surface of the water falls to the lowest safe water line. [This point should be not lower than the bottom of the water glass.] IF A WATER-FEEDING DEVICE IS INSTALLED, IT SHALL BE SO CONSTRUCTED THAT THE WATER INLET VALVE CANNOT FEED WATER INTO THE BOILER THROUGH THE FLOAT CHAMBER AND SO LOCATED AS TO SUPPLY REQUISITE FEEDWATER. THE LOWEST SAFE WATER LINE SHOULD BE NOT LOWER THAN THE LOWEST VISIBLE PART OF THE WATER GLASS.

Unfired Pressure Vessels 1949

FIG. U-4 Delete sketch (f) including note beneath it and substitute the sketch shown hereinbefore under Fig. P-21.

PAR. U-39(a) Revise fifth definition for C to read:

C = 0.50 for plates fusion welded to the inside of a vessel [s] and otherwise meeting the requirements for the respective types of fusion welded vessels, including stress relieving when required for the vessel but omitting radiographic examination, [and where the plate is welded for its entire thickness] WHERE THE WELD HAS A THROAT DIMENSION EQUAL TO TWO TIMES THE REQUIRED THICKNESS OF A SEAMLESS SHELL, BUT NO GREATER THAN THE HEAD THICKNESS NOR IN ANY CASE LESS THAN 1.25 TIMES THE ACTUAL SHELL THICKNESS, AND WHERE THE WELD IS DEPOSITED IN A WELDING GROOVE WITH THE ROOT OF THE WELD AT THE INNER FACE OF THE HEAD, AS shown in Fig. U-4(f) [with a fillet weld having a throat not less than 1.25 times the thickness of the shell or flat head, whichever is smaller]. BEVELING OF THE REMAINDER OF THE HEAD PLATE TO AN ANGLE NOT EXCEEDING 45 DEG IS OPTIONAL.

Unfired Pressure Vessels 1950

TABLE UG-23 Under Bolting, Carbon Steel, opposite SA-307, insert "B" in Grade column. Under Bolting, Alloy Steel, insert the following new top line:

Spec. No.	Grade	Spec. Min Tens	Notes
SA-193	BC	...	(11)(12)

	For metal temperatures not exceeding deg F		
Spec. No.	650	700	750
SA-193	20000	18375	16750...

Under Notes insert new note (12) as follows:

(12) Between temperatures of —20 F to 400 F, stresses are permitted equal to 1.25 times the value specified for the range from —20 F to 650 F.

In Table add reference to note (12) after each of the eight different grades of alloy bolting materials Specifications SA-193
Change present note "(12)," to "(13)" and present note "(13)," to "(14)."

FIG. UG-34 Delete sketch f including note beneath it and substitute the sketch shown hereinbefore under Fig. P-21.

PAR. UG-34 Revise fifth definition for C to read:

C = 0.50 for plates fusion welded to the inside of a vessel [s] and otherwise meeting the requirements for the respective types of fusion welded vessels, including stress relieving when required for the vessel but omitting radiographic examination [and where the plate is welded for its entire thickness] WHERE THE WELD HAS A THROAT DIMENSION EQUAL TO TWO TIMES THE REQUIRED THICKNESS OF A SEAMLESS SHELL, BUT NO GREATER THAN THE HEAD THICKNESS NOR IN ANY CASE LESS THAN 1.25 TIMES THE ACTUAL SHELL THICKNESS, AND WHERE THE WELD IS DEPOSITED IN A WELDING GROOVE WITH THE ROOT OF THE WELD AT THE INNER FACE OF THE HEAD, AS shown in Fig. UG-34(f) [with a fillet weld having a throat not less than 1.25 times the thickness of the shell or flat head, whichever is smaller]. BEVELING OF THE REMAINDER OF THE HEAD PLATE TO AN ANGLE NOT EXCEEDING 45 DEG IS OPTIONAL.

PAR. UG-36(a)(1) Revise first sentence to read:

(1) Openings in the [shell] CYLINDRICAL OR CONICAL SECTIONS of a vessel should be circular, elliptical or obround.[2]

PAR. UG-36(c)(2) After "thickness" in the fourth line delete rest of paragraph and substitute "the construction is presumed to satisfy the requirements of this Code without calculation or proof."

PAR. UG-36(c)(4) In the fourth line, delete "area of."

PAR. UG-38(f) Revise to read:

(f) The minimum width of bearing surface for a gasket on a SELF-SEALING flued manhole opening shall be [$^{11}/_{16}$ in.] IN ACCORDANCE WITH PAR. UG-46.

PAR. UG-41(b) Replace entire paragraph with the following:

(b) On each side of the plane defined in Par. UG-40(b), the strength of the attachment weld or braze between the vessel wall and reinforcement or between any two parts of attached reinforcement shall be at least equal to the smaller of:

(1) The strength in tension of the cross-section, within the area of reinforcement, of the reinforcement attached by the weld or braze being considered.

(2) The strength in tension of the area defined in Par. UG-37 less the strength in tension of the reinforcing area which is integral in the vessel wall as permitted by UG-41(f)(1).

PAR. UG-43 Change side head to "*Methods of Attachment of Pipe and Nozzle Necks to Vessel Walls.*"

PAR. UG-43(d) Make this Par. UG-44(b) and change the first sentence to:

(b) When bolted flanged connections are used for connections to external piping (See Par. U-1(c)(2)) it is recommended that they comply with ASA-B16e-1939 and Supplement No. 1.

PAR. UG-44 Change side head to "*Nozzle Necks and Flange Connections,*" make present paragraph (a).

Make corresponding changes in the lettering of the other subparagraphs of Pars. UG-43 and UG-44.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Power Show to Feature Improved Smoke-Control Equipment

CURRENT efforts to activate New York City's smoke-control ordinance lend special interest to the 19th Exposition of Power and Mechanical Engineering which will be held in Grand Central Palace, New York, N. Y., Nov. 27-Dec. 2. Plans for the exposition are far advanced, assuring exhibits covering every aspect of power from the raw fuel to the light switch or the production machine. A large proportion of the exhibits will deal with fuels, fuel handling and combustion, and a number will reveal improvements directly aimed at the suppression of fumes and dust.

Under ASME Auspices

This year's exposition will be held under the auspices of The American Society of Mechanical Engineers, which has been interested in smoke-control problems for many years. The Model Smoke Law Committee of the ASME held its first meeting in 1940, has been continuously active, and is responsible for developing example sections for a model smoke law that has been studied and used as a basis for law by more than one hundred cities. The Metropolitan Section has co-operated with civic authorities in their efforts to reduce pollution of the New York atmosphere by legal means. William G. Christy, mem. ASME, was recently appointed by Mayor William O'Dwyer as director of the the Bureau of Smoke Control of New York.

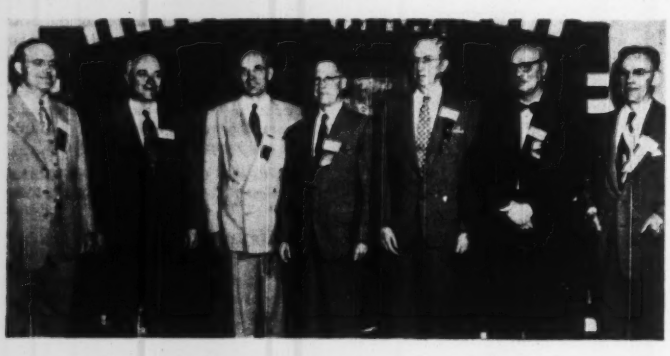
Apparatus particularly appropriate to the problem of smoke suppression, a live issue in many other communities as well as New York, includes oil- and coal-handling equipment, piping, pumps, and burners; grates, fire walls and insulating materials, stokers, draft equipment, fire and draft controls.

Smoke-indicating instruments, of which there will be several displays at the Palace, are recommended equipment for all stationary boiler plants, so that the fireman or operator can know at all times the shade or appearance of any smoke emission from the stack.

One group of exhibits will consist of dust-separating equipment, which also is recommended for all new installations of pulverized coal-burning equipment, spreader stokers, or similar suspension burning types. Dust separators may be of several types, such as settling chambers, baffle collectors, electrostatic collectors, and several types of centrifugal collectors.

Dust Collectors on Exhibit

Centrifugal collectors depend for their action on the inertia of the suspended dust particles. A new type of equipment, the principle of which is in high repute in Europe, where it originated, will be seen for the first time at the exposition. This equipment utilizes the inertia of the dust particles in conjunction with the aerodynamic forces in the draft to produce a highly efficient separation through a series of very fine louvers in a cone-shaped filter element. Equipment of this type is used in chemical and pulp industries, cement and asphalt plants, foundries and machine shops, food and drug processing plants, as well as in smoke purification.



EXECUTIVE BOARD OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION ATTENDING THE 58TH ANNUAL MEETING AT THE UNIVERSITY OF WASHINGTON, JUNE 19-23, 1950

(*Left to Right:* A. B. Bronwell, Northwestern University; J. H. Lampe, North Carolina State College; B. J. Robertson, Mem. ASME, University of Minnesota; Thorndike Saville, New York University; H. H. Armsby, U. S. Office of Education; F. M. Dawson, State University of Iowa; and the host for the convention, Harold E. Wessman dean of the University of Washington College of Engineering.)

Recognition of Engineering Facts of Life Urged

ENGINEERS were urged recently to recognize two "facts of life" by James F. Fairman, president of the American Institute of Electrical Engineers in his presidential address published in the July issue of *Electrical Engineering*. According to Mr. Fairman these facts were: (1) That professional licensure was here to stay; and (2) that the majority of engineers were employed by other engineers.

Engineers, he said, should stop arguing about the value of professional licensure and should devote themselves to making it a useful instrument for the advancement of the profession and protection of the public.

The engineers who employ other engineers have a professional obligation to the employee engineers because of their position of authority. Such men can influence and even control, the professional development and the economic status of engineers under their direction. Mr. Fairman warned that the employer engineer should not be too busy to give some attention to that obligation.

"Specifically, let us not use the title 'engineer' in any form for people who are not engineers or for positions which do not require engineering training or experience. Let us not assign engineers to jobs which are not engineering. Then let us pay salaries to those in real engineering positions commensurate with their individual training, experience, and ability, and let us treat them as we would like to be treated, both in our economic and professional relationships.

"Let us be sure that we put our professional ideals into practice in our own offices and shops. If we do so, many of the problems of the employee engineer will be well on the way to a solution."

Mr. Fairman concluded that if engineers would go the "second mile" in all these relationships, members of the engineering profession would make more rapid progress in attaining recognition, in improving their economic status, and in developing an over-all organization for advancement of the profession and for constructive public service.

Collective Bargaining for Engineers

THE TWO principles regarding collective bargaining by professional employees which have generally guided the engineering profession since the rise of the labor unions, were given succinct statement recently by the Board of Directors of the National Society of Professional Engineers.

The purpose of the statement of principles is to offer advice to NSPE members and other engineers who may be under pressure to abandon their prerogatives as professional men for the short-term economic advantages offered by unionism.

The principles follow:

1 It is definitely unprofessional for a professional engineer, professionally employed, voluntarily to join a heterogeneous labor union, dominated by, or obligated to, nonprofessional groups.

2 Organizations of professional engineers for collective bargaining in any form are to be deplored, although their existence, for the present, may be condoned under certain circumstances.

Notes on Coming Meetings

ISO 1952 General Assembly to Be Held in U. S.

THE International Organization for Standardization has accepted an invitation from the American Standards Association to hold its 1952 General Assembly in the United States. The United States is one of 29 countries who are members of the international standardization body.

The United States viewpoint on standardization is represented by the ASA, whose membership is composed of more than 100 national technical societies including The American Society of Mechanical Engineers, trade associations, and some 1700 industrial firms.

The ASME is becoming increasingly active in international standardization It is currently contributing to 7 international standardization projects including one on test pressures for the acceptance of stationary boilers and unification of boiler construction codes, of which the ASME Boiler Code Committee is serving as secretariat.

Other projects include screw threads, limits and fits, steam turbines, hydraulic turbines, internal-combustion engines, and graphical symbols.

The ASME Board on Codes and Standards is considering Society participation in projects on measurement of fluid flow and pump testing.

Invitations have been received from the ISO for American participation in three other projects.

In all, the ISO has 71 international technical committees working to bring about agreement on definitions, terminology, specifications, dimensions, and test methods in the national standards of the member countries to increase understanding and easier interchange of products.

Countries now members of the ISO are: Australia, Austria, Belgium, Brazil, Canada, Chile, Czechoslovakia, Denmark, Finland, France, Hungary, India, Israel, Italy, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Switzerland, Sweden, Union of South Africa, United Kingdom, Uruguay, United States of America, Union of Soviet Socialist Republics, and Yugoslavia.

Building Research

THE first international congress on building research will be held in London, Sept. 11–20, 1951. The congress is being sponsored by the British engineering institutions, learned societies interested in building science, government departments, and industrial federations.

All aspects of the building art and science will be covered, including heating and cooling of buildings, mechanization of building operation, prefabrication, and structure design.

Those interested in the meeting may write for additional information to: The Organizing Secretary, Building Research Congress 1951, Building Research Station, Bucknalls Lane, Garston, Watford, Herts, England.

Industrial Hydraulics

THE sixth annual National Conference on Industrial Hydraulics will be held at the Sherman Hotel, Chicago, Ill., Oct. 18–19, 1950.

The conference is sponsored by the Armour Research Foundation and Graduate School of the Illinois Institute of Technology in cooperation with seven technical societies.

The tentative program consists of 10 sessions at which 20 papers will be read. Of these, five will be by members or Fellows of The American Society of Mechanical Engineers. They are:

"Cavitation in Piston and Gear Type Pumps," by R. J. S. Pigott, Fellow ASME, Gulf Research and Development Company, Pittsburgh, Pa.

"Volute Vs. Diffusion Casing for Centrifugal Pumps," by A. J. Stepanoff, Mem. ASME, Ingersoll-Rand Company, Phillipsburg, N. J.

"Effect of Rate of Shear on Viscosity," by Sidney J. Needs, Mem. ASME, Kingsbury Machine Works, Philadelphia, Pa.

"New Developments in Reciprocating Pumps," by E. F. Wright, Mem. ASME, Worthington Pump and Machinery Corp., Harrison, N. J.

"Application of Centrifugal Pumps," by A. E. Harnsberger, Mem. ASME, Pure Oil Company, Chicago, Ill.

Other papers will cover such subjects as aircraft hydraulic equipment problems, large hydraulic presses in Germany before and during World War II, large sewage pumps, and hydraulic dredging.

For additional information, write to Prof. Frank W. Edwards, chairman, civil-engineering department, Illinois Institute of Technology, Chicago 16, Ill.

Meetings of Other Societies

Sept. 12–14
Society of Automotive Engineers, Inc., tractor meeting, Hotel Schroeder, Milwaukee, Wis.

Sept. 18–22
Instrument Society of America, national instrument conference and exhibit, Buffalo, N. Y.

Sept. 26–29
Association of Iron and Steel Engineers, annual convention, Hotel Statler and Public Auditorium, Cleveland, Ohio

Sept. 27–30
Society of Automotive Engineers, Inc., aeronautic meeting and aircraft-engineering display, The Biltmore Hotel, Los Angeles, Calif.

Oct. 9–11
National Council of State Boards of Engineering Examiners, 30th anniversary meeting, Congress Hotel, Chicago, Ill.

Oct. 11–13
American Society of Civil Engineers, fall meeting, Congress Hotel, Chicago, Ill.

Oct. 12–13
Gray Iron Founders' Society, 22nd annual meeting, Netherland Plaza Hotel, Cincinnati, Ohio

Oct. 15–19
Technical Association Pulp and Paper Industry, 5th engineering conference, Hotel Netherland Plaza, Cincinnati, Ohio

Oct. 16–20
National Safety Council, 38th national safety congress and exposition, Stevens Hotel, Chicago, Ill.

Oct. 20–21
Engineers' Council for Professional Development, annual meeting, Tudor Arms Hotel, Cleveland, Ohio

Oct. 23–25
American Gear Manufacturers Association, semiannual meeting, Edgewater Beach Hotel, Chicago, Ill.

Oct. 23–27
American Society for Metals, national metal congress and exposition, Palmer House, Chicago, Ill.

Oct. 30–Nov. 1
National Lubricating Grease Institute, annual meeting, Edgewater Beach Hotel, Chicago, Ill.

(For ASME Calendar of Coming Events see page 766)

Engineering Literature

Preferred Thicknesses

A PROPOSED revision of American Standard Preferred Thicknesses for Uncoated Thin Flat Metals, B32.1-1941, has been prepared by the Sectional Committee on Standardization of Wire and Sheet Metal Gages. Those wishing to comment on the proposal may obtain copies from the Standards Department of The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y. Revision of this existing standard will be developed to its final form before the proposed new standard on preferred wire sizes is released for comment.

Milling Cutters

A REVISION of the 1930 American Standard Milling Cutters (ASA B5.3-1950) was recently published by The American Society of Mechanical Engineers.

The revision was made to bring the old standard into harmony with the American Standard for Machine Tapers (ASA B5.10-1932) and to increase its usefulness by enlarging its scope in the light of interim de-

velopments in cutting design, tool material, and machine improvements. This standard does not contain information on hobs because a separate standard on this subject is now being formulated. The 89-page standard is divided into three parts: It covers: (1) nomenclature; (2) milling-cutter dimensions; and (3) mounting elements. In addition to more than 50 illustrations of milling cutters, the standard includes 57 tables. Price is $2.25.

Industrial Power Trucks

AMERICAN Standard Safety Code for Industrial Power Trucks (ASA B56.1-1950) was recently published by The American Society of Mechanical Engineers. The 31-page code, the need of which was first discussed at the Semi-Annual Meeting of the ASME in 1946, defines safety requirements relating to the elements of design, operation, and maintenance of industrial power trucks of both the driver-ride and driver-lead type, such as platform trucks, tractors, low-lift trucks, high-lift trucks, fork trucks, special industrial trucks, etc., but does not include motor vehicles intended for use upon land highways.

The code points out that use of industrial power trucks is subject to certain hazards that cannot be overcome by purely mechanical means, but only by the exercise of intelligence, care, and common sense. An important factor in safety, it states, is the employment of competent and careful operators who are physically and mentally fit and thoroughly trained. The serious hazards such as overloading, slipping of the load, obstruction in the path of travel or lift, use of equipment for a purpose for which it was not intended or designed, can be eliminated if users and manufacturers adhere to the practices recommended by the new code. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price per copy is 85 cents.

Gears

AMERICAN Standard 20-Degree Involute Fine-Pitch System for Spur and Helical Gears (ASA B6.7-1950) was recently published by The American Society of Mechanical Engineers. The standard is a revision of two previous standards developed by the American Gear Manufacturers Association for fine-pitch gears.

In the present standard, nomenclature and symbols are brought up to date and made to conform with other ASA standards. The length of pinion size was extended down to seven teeth because pinions of this size are used in many servomechanisms. But the use of pinions with fewer than 10 teeth is discouraged because of the low contact ratio and profile sensitivity.

In the revision, careful consideration was given to the pressure angle of 20 deg which was chosen after prolonged discussion of tooling problems and other pertinent factors.

The 16-page standard contains tables, data sheets, charts, and examples concerning pinion enlargements. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price is $1.50.

Interpretations of Code for Pressure Piping

PENDING revision of the Code for Pressure Piping, ASA B31.1-1942, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Cases 1, 2, 3, and 4 are published herewith as interim actions of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Case No. 1

Inquiry: May seamless alloy steel pipe complying with ASTM Specification A315 be used under Section 1 of the Code for Pressure Piping?

Reply: It is the opinion of the Committee that pipe complying with ASTM Specification A315 may be used. The permissible stresses shall be as follows:

Deg F	Psi
650	12,000
700	12,000
750	12,000
800	11,800
850	11,200
900	10,000
950	8,000
1000	5,850
1050	3,850
1100	2,200

Case No. 2

Inquiry: Is it permissible to use the revised pressure-temperature ratings for steel pipe flanges and flanged fittings contained in Supplement No. 1 to ASA B16e-1939 (ASA B16e6-1949) for piping systems covered by the Code for Pressure Piping?

Reply: It is the opinion of the Executive Committee that the revised pressure-temperature ratings may be used for all piping systems covered by the Code.

	Temperature, F				
	650	700	750	800	850
ASTM A-158, Gr.P-11	12,000	12,000	12,000	11,800	11,200
ASTM A-213, Gr.T-21	12,000	12,000	12,000	11,800	11,200
ASTM A-213, Gr.T-22	12,000	12,000	12,000	11,800	11,200

	Temperature, F				
	900	950	1,000	1,050	1,100
ASTM A-158, Gr.P-11	10,000	8,000	5,850	3,850	2,200
ASTM A-213, Gr.T-21	10,000	8,250	6,250	4,800	3,700
ASTM A-213, Gr.T-22	10,000	8,250	6,250	4,800	3,700

Case No. 3

Inquiry: May seamless alloy steel piping, complying with ASTM Specifications A-158, Gr. P-11 and A-213, Gr. T-21 and T-22 be used under Section 1 of the Code for Pressure Piping?

Reply: It is the opinion of the Committee that pipe complying with ASTM Specifications A-158, Gr. P-11 and A-213, Gr. T-21 and T-22 may be used. The permissible stresses shall be as shown in preceding table.

Case No. 4

Inquiry: Paragraph 105e limits the use of pipe to specification API-5L as power piping to plants in oil refineries, or those owned and operated by oil companies. May this material be used for power piping in plants not so owned or operated?

Reply: It is the opinion of the Committee that pipe to API specification 5-L may be used in place of the corresponding grades of ASTM specification A-53, with the allowable working stresses now shown in Tables 3 and 3a for ASTM specification A-53.

F. W. Green Elected Fellow ASME

FREDERICK WILLIAM GREEN, president, St. Louis Southwestern Railway Lines, St. Louis, Mo., was elected to the grade of Fellow ASME. Mr. Green was born in Rock Island, Ill., April 30, 1877, where he received his early training in the public schools, later continuing his advanced studies under private tutors. From 1893 to 1917 Mr. Green rose from subordinate positions on various Midwestern railroad lines to become assistant to the president, St. Louis Southwestern Railway Lines. When the U. S. entered World War I he was appointed captain, Corps of Engineers, U. S. Army, in 1917, and in 1919 when he was honorably discharged he was a lieutenant colonel. His excellent record in the Transportation Service won for him the Distinguished Service Medal, U. S. A.; Officier de la Legion d'Honneur, France; and Imperial Order of St. Nicholas, Russia. On his return to the States in 1919 he resumed his work with St. Louis Southwestern and in 1947 became president of the line. The school of mines and metallurgy, University of Missouri, at Rolla, conferred on Mr. Green the honorary DE degree in 1940. He has contributed many articles on railway engineering to the leading technical publications.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

ASME NEWS

Three National ASME Events in September to Launch Promising 1950–1951 Season

A NATIONAL meeting and two professional division conferences are on the calendar of meetings of The American Society of Mechanical Engineers for the month of September. While most members were enjoying the relaxation and diversion of summertime the program-making agencies of ASME were corresponding and conferring in the task of arranging the events which would inaugurate the 1950–1951 season and would engage the attention of members with the coming of cooler weather.

All three of the September events will take place during the last two weeks of the month. There is plenty of time for each member to review again the interesting papers to be presented at each of these meetings and to arrange for hotel accommodations in the respective headquarters hotels.

Some of the high lights follow:

The 1950 Fall Meeting

The 1950 Fall Meeting will be held in the Hotel Sheraton, Worcester, Mass., Sept. 19–21, and will offer a three-day program consisting of 23 technical sessions at which more than 50 papers will be presented. (For a detailed account of the technical program, see pages 677 and 678 of the August issue.) A feature of the program will be the 1950 Calvin Rice Lecture to be delivered by Luigi Broglio, professor of aeronautical structures at the Graduate College of Rome, who was recently appointed a visiting professor at Purdue University. His subject will be "The Method of Equivalence Applied to Engineering and to Mathematical Physics."

Junior members in Region I will not want to miss the conference on "How is Your P.D.?" (professional development) sponsored by the National Junior Committee. This conference is the third in the series of four which has won the support of older members and juniors alike.

For members who are planning a late vacation, September in New England is an experience cherished by all who have known it. An interesting program has been arranged for wives and guests of members. This includes a visit to Old Sturbridge Village, a restoration of an early-nineteenth-century village, a visit to the Worcester Art Museum, and other social events.

Instruments and Regulators Conference

The 1950 Annual Conference of the ASME Instruments and Regulators Division will be held in co-operation with the Fifth Annual Instruments Conference and Exhibit of the Instrument Society of America at the Memorial Auditorium, Buffalo, N. Y., Sept. 18–22, 1950.

The technical program will consist of four sessions at which 12 papers will be presented on such subjects as blast furnaces, radiation pyrometry in the steel industry, measurements as a career or avocation, compressibility effects in hydraulic servomechanisms, and others. (For a complete account of the tentative program, see pages 678 and 679 of the August issue.)

C. C. Furnas, director, Cornell Aeronautical Laboratory, will address ASME members of the Instruments and Regulators Division on "Research in Industry." Of special interest to mechanical engineers will be an instrument exhibit staged under the auspices of the Instrument Society of America, at which the latest developments in the field of instrumentation will be demonstrated.

Petroleum Division Conference

The Petroleum Mechanical Engineering Conference sponsored by the ASME Petroleum Division will be held at the Hotel Roosevelt, New Orleans, La., Sept. 25–28, 1950.

The technical program will be composed of five technical sessions under each of the following headings: Production, transportation, and refining. The sessions under each heading will constitute an integrated series which will run concurrently with the sessions planned under the other two headings. In all, 36 pages will be read—all under the over-all theme "Cost Reduction." (For detailed account of the technical programs, see page 679 of the August issue.)

The conference is significant because it brings together authorities in the field of petroleum mechanical engineering from 28 companies, one research institution, and one university.

Members attending the conference will be asked to pay a fee of $2 and nonmembers $3, for which each will receive a package of all available preprints of papers to be presented.

A high light of the program will be an all-day trip on Thursday, Sept. 28, to the Freeport Sulphur Company, Port Sulphur, La. The trip will consist of a 10-mile excursion through the scenic bayou country, an inspection of the sulphur-production facilities, and a luncheon, following which the party will return to the hotel later in the afternoon. Members planning to make this interesting trip should register early so proper facilities can be provided for them.

ASME Publicity

MORE than 2000 news stories of the activities of The American Society of Mechanical Engineers appeared in newspapers and magazines around the country during 1949, according to George A. Hastings, ASME public-relations director. This adds up to more than 1200 newspaper columns and sets a new record in the volume of information published in the American press about the Society and its activities. In fact, it would be enough to fill the entire 152 text pages of a Sunday issue of *The New York Times*.

The total amount of news stories printed about the ASME in 1949 was 500 more than during the previous year. A sharp increase in interest in the general activities of the Society was especially noted, with the number of such stories jumping from a little over 400 in 1948 to more than 730 in 1949, an increase of almost 80 per cent. More space in the country's press was also given to the four large national meetings of the ASME last year. Here the percentage of increase ranged from 16 to over 35 per cent. These figures are an indication of the growing interest with which the actions of the Society are being viewed by the American press and public.

ASME Company List

FOR use in connection with Society or professional affairs, The American Society of Mechanical Engineers has recently published a list of its members arranged alphabetically under the names of the companies by which they are employed. The 203-page publication is designated as ASME Annual AM-4 and is available to members of the Society at $2 per copy.

Members employed by colleges and universities, federal government, state, county, and city governments, and foreign governments, are listed in different sections of the publication. The list does not include student members, postgraduate students, or the retired.

Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York, N. Y.

Metropolitan Section Fall Review Courses

THE Metropolitan Sections of the ASME and the AIEE announce the fall program of Review Courses to prepare engineers for New York and New Jersey professional engineer's license examinations. Two speech courses will also be offered for those engineers who wish to be able to speak effectively before an audience.

The following courses will be given: Engineering Economics and Practice, Structural Planning and Design, Mechanical Engineering, Electrical Engineering and Applications, Effective Speaking, and others.

The courses will be offered starting Sept. 5, 1950.

For details write to The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

Civic Responsibility of Engineers to Be Theme of 1950 ASME Annual Meeting

Society to Sponsor Power Show

IN a world divided by conflicting ideologies The American Society of Mechanical Engineers during its 1950 Annual Meeting to be held at the Hotel Statler, New York, N. Y., Nov. 26–Dec. 1, is again turning its attention to two of the important bulwarks of the American way of life—the engineering profession, and the American system of free enterprise.

The theme of the meeting will be "The Engineer and His Civic Responsibility." A. W. Robertson, chairman of the board of Westinghouse Electric Corporation, will sound this keynote at the president's luncheon on Monday, Nov. 26, when he speaks on "The Individual and Free Enterprise."

Mr. Robertson's remarks are expected to have special significance for student and junior members as well as older members of the Society, whose faith in the American way of life may be intuitive, and who need to have at their fingertips the facts and philosophy to defend and proselytize it.

This event may inspire some ASME members in a position to do so, to make it possible for young engineers on their staff to be present at the president's luncheon.

Engineers who have made it a habit to underwrite the attendance at the Annual Meeting of some promising engineering student should plan to register Monday morning so as not to miss Mr. Robertson's remarks.

As in the past few years, members who may not wish to participate in the luncheon part of the program need not miss Mr. Robertson's talk. Arrangements will be made to have extra chairs in the luncheon hall so that after the luncheon has been served, the doors will be opened for all who care to listen in comfort to the program which will follow.

Management Program

A feature of the meeting will be the program of the Management Division devoted to small-plant management problems. This will begin with a talk by D. G. Mitchell, president, Sylvania Electric Products, Inc., on "Why Sylvania Operates in Small-Plant Units," and will continue with four other papers by management authorities in the small-plant field on such topics as the economic problems of small plants and their solutions; know-how management for small plants, new tasks in engineering for small plants, and small-plant management abroad.

1950 National Power Show

This year as never before the Power Show under the auspices of the ASME is being more closely tied in with the program of the Annual Meeting. The show opens Monday at 2 p.m. and will be open every day of the meeting from 11 a.m. to 10 p.m. except on Wednesday, the night of the Annual Dinner, and on Saturday, the day following the meeting, when the hours will be from 11 a.m. to 6 p.m. Because the engineer's civic responsibility often manifests itself in his interest in equipment and methods of control of atmospheric pollution, the Power Show will have one of the best collections of such equipment ever assembled in New York in addition to an unusual display of varied equipment used in the power-plant field and throughout industry. On the floor at Grand Central Palace among the hundreds of exhibits, just as at the ASME Annual Meeting Headquarters at the Hotel Statler, members will find occasion for making new friends and renewing old friendships.

Junior Conference

For junior members who have recently entered the ranks of ASME corporate membership and whose paramount concern may be some aspects of how they are doing in the job of growing into a professional engineer, the Junior Conference on the topic "How Is Your P.D.?" (professional development) should be a rewarding experience. This event will be the culmination of the 1950 program of the National Junior Committee which included similar conferences in Washington, D. C., St. Louis, Mo., and Worcester, Mass. Each conference swelled the fund of new ideas contributed by young members of the ASME residing in Regions II, III, and VI. The conference at the Annual Meeting can be expected to crystallize these ideas and give further impetus to the Society's junior activities.

Technical Sessions

While the tentative program is still in the formative state and will not be announced in detail until the October issue, some idea of the wealth of material prepared for presentation and discussion can be had by a glance at the subjects covered by papers grouped under topical headings which are being scheduled for the sessions.

Boiler Feedwater: Simplified apparatus for determining the dissolvable solids in steam by electrical conductivity; prevention of embrittlement cracking; solubility of quartz and some other substances in superheated steam at high pressures.

Education: The ECPD—what it is and what it does.

Furnace Performance Factors: Furnace-heat absorption in pulverized-coal-fired steam generator, Willow Island Station.

Heat Transfer: Strain-hardening and softening with time in reference to creep and relaxation; relaxation of stress in heat-exchanger tube of ideal material; expanded tube joints in feedwater heaters and heat exchangers; analysis of stresses and displacements in heat-exchanger expansion joints; expansion joints for heat exchangers; effect of mechanical design on the life of tubes in heat exchangers; aluminum alloys in heat-exchanger construction; a leak-proof heat exchanger; heat transfer in rocket motors and application of film and sweat cooling; intermittent heating for aircraft deicing, with application to propellers and jet engines; calculation of heat transfer in solids with temperature-dependent properties; study of the mechanism of boiling heat transfer; radiant gas burners; emittances of oxidized metals; radiant interchange configuration factors; heat and momentum transfer through steam in plain and modified annuli; heat transfer to a fluid flowing turbulently in a smooth pipe with walls at constant temperature; precise measurement of temperature as an aid to the study of heat transfer; theory of the oil cooler, heat exchange, and pressure drop in slots with parallel walls at variable viscosities.

Hydraulics: The possibility of balanced flow in compressor and turbine blading; influence of Reynolds number on performance of turbomachinery; measured performance of pump impellers; method for calculating the degree of flow deviation at the discharge of centrifugal-pump impellers; investigation of flow through screens; index testing of hydraulic turbines; round-table discussion on various phases of cavitation.

GEORGE WASHINGTON BRIDGE ACROSS HUDSON RIVER FROM NEW YORK SIDE

Industrial Instruments and Regulators: Precision and accuracy of orifice-meter installations; controller settings for optimum control; improved pneumatic control system; pitot-venturi flow element; development of a high-dynamic-performance hydraulic servo; metastable flow of saturated water; and dynamic force reactions in double-portal control valves.

Machine Design: Some design aspects of metal-powder parts; the fields of utility of investment casting; furnace brazing of machine parts; machine design as a career; dynamic loading of chain drives.

Management: Standards give assurance; standards aid quality control; panel discussion on visual aids for management education; planning your future; what industry expects of and the opportunities it offers to the young engineer in our system of free enterprise; significance of the General Motors-United Automobile Workers five-year contract; employee communications through SKF development program; practical aspects of methods-time measurement application; and productivity standards, sales, and warehousing.

Power: Shaving of pinions and gears for marine propulsion plants; the engineering of a 30,500-ton supertanker, the first ship using 1020 F steam; intake-tunnel design for condenser circulating pumps; fireside deposits of steam generators minimized through humidification of combustion air; resuperheating in steam-turbine plants; high-temperature properties and characteristics of a ferritic steam piping; report on split steam lead at New Orleans; stress and deflection tests of steam-turbine diaphragm.

Railroad: Performance experience with double-screened locomotive fuel; a cinder-collection and ash-disposal system for coal-burning locomotives; development of special freight cars designed for protection of lading; progress in railway mechanical engineering; free piston compressor; and design factors and construction of aluminum tank cars.

Rubber and Plastics: Pressures developed by viscous materials in the screw extrusion machine; strength behavior of adhesive bonds; and the creep properties of lucite and plexiglas for tension, compression, bending, and torsion.

13th AIME-ASME Joint Fuels Conference to Be Held Oct. 24–25

Julian E. Tobey to Receive Percy Nicholls Award

A SYMPOSIUM on coal characteristics affecting burning equipment, in which five authorities representing manufacturers and users of coal equipment will participate, will be a feature of the 13th AIME-ASME Joint Fuels Conference to be held at the Statler Hotel, Cleveland, Ohio, Oct. 24–25, 1950. The conference will be sponsored by the Coal Division of the American Institute of Mining and Metallurgical Engineers, and the Fuels Division of The American Society of Mechanical Engineers. Also co-operating in the conference will be the Cleveland Engineering Society.

The conference will be the thirteenth in a series which began in 1937 to provide a forum before which coal users and coal producers could discuss common problems for mutual benefit.

Since that time the Societies have continued to sponsor the joint conference, first one and then the other shouldering the administrative responsibility for arranging the program.

Except in 1945 when travel restrictions made the conference impossible, 300 to 500 engineers active in the coal industry have attended the event annually. An established event of the industry, the 1950 conference is expected to attract a good attendance.

At the banquet on Tuesday, Oct. 24, the conference will honor Julian E. Tobey, president, Appalachian Coals Inc., Cincinnati, Ohio, for notable industrial achievement in the field of solid fuels, by conferring on him the Percy Nicholls Award for 1950. Mr. Tobey is credited with improving practices of coal burning and the application of coal-burning equipment through a comprehensive series of fuel engineering conferences which he organized in most of the industrial centers of the United States. As a result of these conferences, much progress was made in improving combustion equipment and boiler fuels for greater flexibility so that a wider range of coals could be used.

The award was established in 1942 by the AIME and ASME. E. G. Bailey, Arno C. Fieldner, and Larry A. Shipman are among those who have received the award.

The 1950 conference will consist of four technical sessions at which eight technical papers will be read.

The social program will consist of two luncheons and a banquet. H. G. Dyktor, commissioner, Division of Air Pollution, City of Cleveland, will speak on "Meet the Smoke Inspector" at the opening luncheon on Tuesday. At the banquet, Elmer L. Lindseth, president, Cleveland Electric Illuminating Company, Cleveland, Ohio, will discuss "The Kilowatthour in War and Peace." In addition to the presentation of the Percy Nicholls Award, John Rowland Brown, president, Reliance Gage Column Company, Cleveland, Ohio, will be presented with a certificate and pin honoring his 50 years' membership in the ASME.

At the Wednesday luncheon, George E. Whitwell, vice-president, Philadelphia Electric Company, Philadelphia, Pa., will talk on the subject, "Competitive Aspects of the Utility Business."

For the wives and guests of members the women of the Cleveland Section under the chairmanship of Mrs. William Stewart, have organized a program of entertainment which will include a tea on Tuesday and a luncheon on Wednesday at the Carter Hotel, during which Miss Arms, Halle Bros., will talk on "Fashion Trends and What to Expect."

The tentative program follows:

TUESDAY, OCTOBER 24

9:00 a.m.

Registration

10:00 a.m.

Session I

Panel

Coal Characteristics Affecting Burning Equipment

Underfeed Stokers, by *J. S. Bennett*, American Engineering Company, Philadelphia, Pa.

Pulverized Coal, by *Roger Curfman*, Cleveland Electric Illuminating Company, Cleveland, Ohio.

Spreader Stokers, by *Charles Hallman*, Detroit Stoker Company, Cleveland, Ohio.

Chain Grate Stokers, by *Harry Huston*, Johnston-Jennings Division, Pettibone-Mulliken Corp., Cleveland, Ohio.

Cyclone Furnaces, by *Frank X. Gilg*, Babcock & Wilcox Company, New York, N. Y.

Gas Analyzers for Better Combustion, by *C. H. Barnard*, Bailey Meter Company, Cleveland, Ohio.

12:30 p.m.

Luncheon

Presiding: *Elmer Kaiser*, chairman, Fuels Division, ASME.
Speaker: *H. G. Dyktor*, commissioner, Division of Air Pollution, Cleveland, Ohio.
Subject: **Meet the Smoke Inspector.**

2:00 p.m.

Session II

The Causes and Probable Effects of Today's Fuel Situation, by *H. A. Baldwin*, General Motors Corporation, Detroit, Mich.

A Pattern for Sound Utility Fuel Procurement, by *Marshall Pease, Jr.*, and *R. J. Brandon*, The Detroit Edison Company, Detroit, Mich.

7:00 p.m.

Banquet

Toastmaster: *Thomas A. Marsh*, Iron Fireman Manufacturing Company, Cleveland, Ohio.
Speaker: *Elmer L. Lindseth*, president, Cleveland Electric Illuminating Company, Cleveland, Ohio.
Subject: **The Kilowatt Hour in War and Peace.**
Awards: Percy Nicholls Award to *J. E. Tobey*, president, Appalachian Coals, Inc., Cincinnati, Ohio.
50-Year Member Award to *John Rowland Brown*, president, Reliance Gage Column Company, Cleveland, Ohio.

WEDNESDAY, OCTOBER 25

10:00 a.m.

Session III

Coal Sampling by Large Increment Weights, by *B. A. Landry*, Battelle Memorial Institute, Columbus, Ohio, and *W. W. Anderson*, Commercial Testing and Engineering Company, Charleston, W. Va.

The Effect of Coal Size on the Sampling of Coal for Float and Sink Tests, by *A. L. Bailey*, United States Bureau of Mines, Washington, D. C., and *B. A. Landry*, Battelle Memorial Institute, Columbus, Ohio.

12:30 p.m.

Luncheon

Presiding: *Carroll F. Hardy*, chairman, Coal Division, ASME.
Speaker: *George E. Whitwell*, vice-president, Philadelphia Electric Company, Philadelphia, Pa.
Subject: **Competitive Aspects of the Utility Business.**

2:00 p.m.

Session IV

Frothing Characteristics of Pine Oils in Flotation, by *Shiou-Chuan Sun*, Pennsylvania State College, State College, Pa.

Dewatering of Fine Coal, by *C. C. Wright*, Pennsylvania State College, State College, Pa.

An Investigation of the Abrasiveness of Coal and Its Associated Impurities, by *H. F. Yancey*, *M. R. Geer*, and *J. D. Price*, U. S. Bureau of Mines.

The President's Letter

ASME Dues Increase

To ASME Members:

LAST year your Society invested more than a million dollars in the advancement of mechanical engineering as a profession—that is, in doing our collective job. Expendable income received in that year exceeded expense by the slim margin of $4.25.

In an era of inflation and urgent demand for increased service to our profession and the Nation we are attempting to operate on a scale of dues set in 1924 and unchanged since that time. We have supplemented dues income by such fruits of our labors as the public is willing to purchase and by contributions from industry toward the cost of special projects. This we shall continue to do. But this source of income will diminish and dry up if we do not nourish and replenish it with new projects and services which originate in activities largely supported by the dues you pay.

Action to increase dues was recommended to the Council by the Group Delegates Conference, as announced in the August, 1950, issue of MECHANICAL ENGINEERING; and the Business Meeting at St. Louis in June voted to refer, by letter ballot of ASME members, an amendment to the Constitution adding $5 to the dues for all grades of membership except those student and junior members under 30. You will shortly receive the letter ballot and a statement of the reasons which prompted the proposal to increase the dues.

The decision is in your hands. A favorable vote will stop further curtailment of services for your benefit. An overwhelmingly favorable vote will be interpreted by your officers and the Council as your desire to make ASME an even more effective agency for the welfare of the engineering profession and the Nation than it has been in the past.

JAMES D. CUNNINGHAM, *President*, ASME

Policies on ASME Budget for 1950–1951

THE FOLLOWING statement of policies with the schedule of income and expense constitutes the Budget for 1950–1951.

1 A continuous effort will be made to collect dues by regular monthly billings. Quarterly payments will be accepted.

2 No appropriation shall be made by Council without first referring back to the Finance Committee for recommendation. When a liability is assumed, the means for paying for it shall be provided in advance.

3 No new activity shall be undertaken without definitely showing that the funds required to support it will be available without decreasing the appropriations for existing essential activities, giving the consideration to the administrative expense that may be involved. When a new activity is authorized, if the additional funds to support it are not directly available from the unappropriated income, Council shall say what activity shall be curtailed or suppressed to permit transference of the fund required to support the new activity.

If the budget of expenses is to be reduced, the Council shall say what activity shall be curtailed or suppressed.

4 The Society shall hold four general meetings with expense chargeable to the budget. A fee shall be charged to nonmembers for admission to general or technical sessions at the four meetings of the Society according to rules established by the Board on Technology.

5 Council meetings shall be held at the place and time of the Annual and Semi-Annual Meetings. Council representation within the budget shall be provided for the other national meetings.

6 Within the allowance of the budget, Vice-Presidents shall be expected to visit Sections and Student Branches and attend Student Branch Conferences in their Regions or arrange for visits by their representatives.

7 No travel allowance will be provided for Board and Committee Chairmen attending Council meetings except upon special provision of Council or the Executive Committee.

8 Eight Regional Administrative Committee meetings will be held.

9 A Regional Delegates Conference will be held at the place of the Semi-Annual Meeting.

10 The Nominating Committee may hold a preliminary meeting at a place to be selected and a Selection meeting at the Semi-Annual Meeting within the provisions of the budget.

11 The following uniform basis of contribution toward travel expense shall be adopted: 5 cents per mile one way plus allowance of $3.50 per diem for time at the meeting not exceeding two days plus total traveling time by standard railroad route plus 50 per cent for the Council, 1950–1951 Nominating Committee, Regional Administrative Committees, Sections and Regional Delegates. When Board and Committee Chairmen are required to attend Council meetings, the same provisions will be made.

For Student Branch Conference—13 cents per mile for each Student Branch Delegation, including the honorary chairman. Student delegations under this provision may consist of (a) the honorary chairman, (b) the honorary chairman and at least one student delegate, or (c) one or more student delegates.

Visits of President and Vice-Presidents or their designated representatives to Sections, Branches, etc.—out of pocket expense within budgetary limits prescribed.

12 The Society shall have two representatives on the American Standards Association.

13 No publications shall be printed for sale unless there is reasonable assurance of sufficient orders to pay for the cost.

COMBINED ANALYSIS OF EXPENDITURE BUDGET 1950–1951

	Under Committee Supervision			Printing and Distribution	Office Expense	Total
	Joint Bodies	Members Travel	Others			
PUBLICATIONS, STANDARDS, CODES AND RESEARCH						
MECHANICAL ENGINEERING text pages (excluding student copies)				$66,000	$29,535	$ 95,535
MECHANICAL ENGINEERING advertising pages (excluding student pages)				93,100	68,420	161,520
Transactions (including *Journal of Applied Mechanics*)			$ 1,100	15,200	18,595	34,895
Membership List				8,000		8,000
ASME Catalog				48,000	42,350	90,350
Publication sales (except standards, codes, and research reports)				46,100	16,942	63,042
Standards and codes	$1,000			52,900	81,968	135,868
Research				5,500	5,720	11,220
GENERAL SOCIETY ACTIVITIES						
Society meetings (including publicity)			28,000		15,580	43,580
Sections (including regional administration committee of Regional Delegates Conference)		$14,500	56,000		17,805	88,305
Professional divisions			7,700		14,930	22,630
Student Branches (including copies of MECHANICAL ENGINEERING text and advertising pages)		4,000	9,000	50,000	13,435	76,435
Admissions					20,700	20,700
Development					5,000	5,000
Awards			1,000		600	1,600
Engineers Civic Responsibility		500				500
GENERAL SOCIETY ADMINISTRATION						
Council		5,800	1,500			7,300
Professional services (auditors, counsel, etc.)			3,000			3,000
Nominating Committee		2,000				2,000
Retirement Fund			27,700			27,700
"Know Your Society" (organization charts			500			500
JOINT ACTIVITIES						
Engineering Societies Library	14,450					14,450
Engineers' Council for Professional Development	1,900					1,900
Engineers Joint Council	1,500					1,500
Engineering Societies Personnel Service, Inc. (reserve)	500					500
Registration (National Council of State Boards of Engineering Examiners)	500					500
UET pension fund	2,500					2,500
National Management Council	500					500
INDIRECT EXPENSE						
Secretary's office					48,670	48,670
Accounting department					41,060	41,060
General service (stores, mailing, filing, etc.)					82,180	82,180
General Office (rent, insurance, etc.)					43,582	43,582
	$22,850	$26,800	$135,500	$384,800	$567,072	$1,137,022

BREAKDOWN OF ASME BUDGET 1950–1951

	Budget 1950–1951	
MECHANICAL ENGINEERING and Mechanical Catalog income	$410,000.00	
Less production costs, wages and indirect	303,442.00	$106,558.00
General publication sales income	$ 74,000.00	
Less stock costs, wages and indirect	77,997.00	−3,997.00
Engineering Index		3,000.00
Miscellaneous sales		7,500.00
Interest and discount		18,000.00
Membership dues		450,000.00
TOTAL		$581,061.00
MECHANICAL ENGINEERING text (production, wages and indirect)		$115,145.00
Transactions (production, wages and indirect)		43,157.00
Membership List (production, wages and indirect)		9,494.00
Standards and codes (income)	$115,00[illegible].00	
stock cost, wages and indirect	163,97[illegible].00	48,972.00
Research (income)	$ 11,000.00	
Stock cost, wages and indirect	13,511.00	2,511.00
Student dues	$ 48,000.00	
Student expense (production, wages and indirect)	91,006.00	43,006.00
Meetings (income)	$ 2,000.00	
Meetings expense (costs, wages and indirect)	52,024.00	50,024.00
Sections (appropriations, travel, wages and indirect)		105,280.00
Divisions (appropriations, travel, wages and indirect)		27,206.00
Admissions and development (wages and indirect)		31,404.00
Awards (costs, wages and indirect)		1,894.00
Engineers Civic responsibility		500.00
Joint activities		41,030.00
General administration		59,960.00
TOTAL		$579,583.00
NET INCOME		$ 1,478.00

Junior Forum

What Industry Expects of the Junior Engineer

SOUND comment on what industry expects from the newly employed graduate engineer, by M. D. Cooper, director, Mining Engineering Education, National Coal Association, Pittsburgh, Pa., appeared in the June issue of *Mining Engineering*.

Dependability, loyalty, friendliness toward a fellow worker, maturity, independent thinking, adaptability, all have a familiar ring for recent graduates, but Mr. Cooper's lucid statement of basic truths should give young men an insight into the standards of performance by which veteran engineers will judge them.

Mr. Cooper says: "Of the desired characteristics, dependability is of the utmost importance. Probably most employers would overlook certain shortcomings if the young graduate demonstrated that he was thoroughly dependable. If he always appeared at the right place at the right time with the proper equipment, he would soon be well established as a welcomed member of his organization. The graduate who gets a reputation for being undependable will have little opportunity for advancement.

"Closely allied to dependability is loyalty. Athletic teams and social groups in college tend to develop loyalty which may well be carried over into industry. This does not mean that the graduate has to be satisfied with customary practices. The average manager is glad to see the graduate make constructive criticism as long as he demonstrates his loyalty at the same time. It is important that his loyalty keeps him alert and ready to take helpful action for the benefit of his organization, and especially to stand with it during times of stress.

"With or without an introduction to labor relations in college, the graduate is expected to develop ability in this most important field. Beginning with himself, he will find it essential to deal agreeably with his immediate associates. Getting along in friendly fashion with his own small group will be a great help as his responsibilities increase, and he is required to deal with larger numbers of persons. On a higher scale, his interest in his community may grow at the same time by voluntary work in any one of a great number of useful activities.

"Industry expects the graduate engineer to be a mature man at the time he gets his first job. Supposing that he has better than average intelligence, industry expects him to continue to grow intellectually and to fit himself for responsible jobs when they are offered to him. For this reason, employers are apt to look over his college record to see what he did that would indicate his fitness for leadership. There is interest in knowing what he did beyond the requirements.

"As evidence of his mental growth, it is expected that the graduate will do independent thinking; that he will not take too much for granted. When he reads a report, he should develop the ability to see whether the subject is new or whether it is just a description of an old method that has been superseded by something better.

"For the same reason, the graduate should be able to accept conditions that have been arrived at by sound experience rather than cling to something else that seems better in theory. In this connection, it may be remarked that the ability to operate successfully a personal budget will be noteworthy, as it may be assumed that a man who knows how to conduct his own affairs will be prepared to assume the larger responsibilities of industry."

Referring to the professional engineering societies, Mr. Cooper advised young men to become associated with their activities. It would indicate to the employer, he said, that the graduate was interested in his profession. It would be good evidence that the young man had "something more than a local outlook."

Quite apart from college training and mental ability, Mr. Cooper continued, the young engineer will be expected to do hard manual labor for a time. This will give him understanding of the actual conditions of work done by those he supervises later. It will give him confidence and ability to supervise the job in a safe and efficient manner.

ASME Calendar of Coming Events

Sept. 18–22
ASME Instruments and Regulators Division Conference, Municipal Auditorium, Buffalo, N. Y.
(Final date for submitting papers was May 1, 1950)

Sept. 19–21
ASME Fall Meeting, Hotel Sheraton, Worcester, Mass.
(Final date for submitting papers was May 1, 1950)

Sept. 25–28
Petroleum Mechanical Engineering Conference, Hotel Roosevelt, New Orleans, La.
(Final date for submitting papers was May 1, 1950)

Oct. 23–25
ASME Fuels Division Conference, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers was July 1, 1950)

Nov. 26–Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers was Aug. 1, 1950)

April 2–5, 1951
ASME Spring Meeting, Hotel Atlanta-Biltmore, Atlanta, Ga.
(Final date for submitting papers—Dec. 1, 1950)

April 17–19, 1951
ASME Process Industries Conference, Baltimore, Md.
(Final date for submitting papers—Dec. 1, 1950)

June 11–15, 1951
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(Final date for submitting papers—Feb. 1, 1951)
(For Meetings of Other Societies see page 759)

(ASME News continued on page 768)

HOTTER, SOONER steam traps.. knock cold spots out of platens

Cold spots in press platens at this large western plywood plant are a thing of the past since they've installed the steam traps that get equipment *hotter, sooner*—Yarways.

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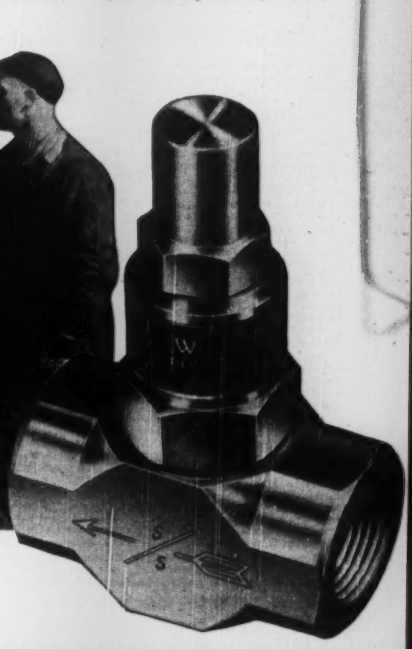

Stainless Steel Body

YARWAY **IMPULSE STEAM TRAP**

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
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Detroit
100 Farnsworth Ave.

San Francisco
57 Post Street

MEN AVAILABLE[1]

TECHNICAL SALES ENGINEER, 32, BSME, plant engineer. 10 years' varied experience aircraft, steel fabricating, machine design, glass manufacturing. Desires permanent change to sales. Me-755.

MECHANICAL ENGINEER, 31, married. Nine years' development work on apparatus, process, and special machinery for metals industry. Research, production, and field experience. Responsible, personable, excellent potential. Seeks technical administrative position such as plant engineer or assistant to chief engineer. Me-756.

MECHANICAL ENGINEER, 34, married, two and a half years design of industrial-processing machinery; two years' design of food-processing equipment and special industrial machinery; three and a half years' aeronautical maintenance. Available two weeks notice. Prefers northern Calif. Me-757-506-D-34.

RECENT GRADUATE, 22, single, BSME, Newark College of Engineering. Desires sales or industrial-engineering position with any industry. Good personal qualifications; preferably in East. Experience in commercial air conditioning. Will travel. Me-758.

SALES ENGINEER, 29, BS, U. S. Naval Academy, family, three and a half years' inside sales experience surface condensers, pumps, power-plant equipment; one year's testing turbine generators, pumps, and deaerators. Desires sales position. Northeastern U. S. Me-759.

MECHANICAL ENGINEER, two and a half years' experience in a machine-shop industry applying time study, production control, plant layout, and methods improvements to line and assembly operations. Me-760.

RECENT GRADUATE, BME, veteran, 25, single. Experience in time study and methods. Seeks trainee or junior engineering position in methods, production, or industrial engineering. Will relocate or travel. Me-761.

MECHANICAL ENGINEER, registered, 34, married. Experienced industrial purchasing and design and development of optical machinery. Now employed. Desires change with opportunities to broaden experience, particularly in production engineering. Me-762.

HYDRAULIC AND PNEUMATIC ENGINEER, mechanical, registered Calif., 32, married. Ten years' experience in engineering design, test research, and development of valves and circuits. Prefers supervisory or other responsible position in West. Will travel. Me-763-507-D-18.

MECHANICAL-ENGINEERING GRADUATE, 21, single BSME, May, 1950. Desires position as junior engineer or trainee in product design and development. Prefers household and/or business appliances. Will relocate. Me-764.

MECHANICAL ENGINEER, 22, BME, 1948, certified engineer in training, New York, single, experienced in drafting, estimating, design, and sales in construction, public-utility, air-conditioning, and refrigeration fields. Prefers Northeast or Midwest location. Me-765.

MECHANICAL ENGINEER, 28, married, veteran, two years' experience oil-refinery maintenance, four years' machine-shop work, desires plant-engineering position, N. Y., N. J. area. Me-766.

POSITIONS AVAILABLE

ENGINEERS. (*a*) Design and development engineer, 35–40, mechanical graduate, design, development, product-engineering, and general machine-shop experience, for staff position with manufacturer of household products and industrial equipment. Small tank and miscellaneous metal fabrication also desirable. $5000–$6000. New York, N. Y. (*b*) Design and development engineer, under 35, industrial-instrument experience, to design instruments for flow measurements and control of liquids and gases. $4000–$5000. Eastern Pa. Y-3346.

RESEARCH SCIENTIST, advanced degree and five to 10 years' experience for responsible position to handle theoretical and experimental projects in the field of engineering mechanics. Subjects of particular interest include nonlinear mechanics, dynamic loading of flexible structures, fatigue of structural components, machine methods of computation. Salary open. Southwest. Y-3914-S.

VICE-PRESIDENT AND GENERAL MANAGER of modest-sized tap and die company. Must have thorough experience in the field. Must be an administrator and sales-minded. Salary open. New York metropolitan area. Y-3950.

INDUSTRIAL ENGINEER, senior, under 40, to take charge of an industrial-engineering department for company engaged in ceramic manufacturing. Must be thoroughly familiar with planning, standards, methods, production control for job-shop type of industry. $7500–$8000. Western Pa. Y-3952.

RESEARCH AND DEVELOPMENT ENGINEER, preferably under 40, mechanical or electrical degree, experienced in the design and development of fabricated metal products; preferably such products as washing machines, refrigerators, electric ranges, etc. $10,000–$14,000. East. Y-3954-D.

QUALITY CONTROL MANAGER who has had minimum of five years' experience in quality control in the textile field. $10,000–$12,000. South. Y-3969.

MECHANICAL ENGINEER, at least 15 years' experience in power-piping design. $5200–$6500. New York, N. Y. Y-4007.

ENGINEERS for job shop using very heavy machinery to manufacture special equipment. (*a*) Production-control department head, to organize and establish procedures for adequate control of planning, scheduling, ordering, dispatching, and stock control. (*b*) Industrial-engineering department head, with heavy experience in time study, operation analysis, preparation of job operation sheets, good record cost-reduction work, experience in tool planning, plant layout, and material handling. $6000–$8000. Midwest. Y-4010.

TEACHING PERSONNEL. (*a*) Instructor or assistant professor, MS degree, plus one year of teaching experience. Industrial experience desired, to teach junior basic theory and application and possibly some senior power transmission, symmetrical components, or servomechanisms. $3300–$4000 for nine months. (*b*) Assistant professor or associate professor, doctor's degree, plus two years' teaching experience, plus industrial or development experience, to teach senior year power courses. $4000–$4800 for nine months. Housing available for family. Midwest. Y-4011.

PROCESS ENGINEER, mechanical, experienced with machine-tool design. Knowledge of machine-shop processes. Will design, layout, and supervise fabrication and installation of production equipment and set up production lines for an army ordnance installation. $4600. Ill. R-6630.

CHIEF DEVELOPMENT ENGINEER, three years' experience required, with refrigerating-equipment development, commercial units, and systems. Knowledge of refrigeration principles. Informed about laboratory techniques, to take charge of experimental and development laboratory for manufacturer of commercial refrigeration. Salary open. Ill. R-6642.

ENGINEERS. (*a*) Research engineer, knowledge of aircraft and guided missiles, to supervise and conduct research on performances, characteristics, and technical capabilities of foreign aircraft and guided missiles. F.B.I. clearance necessary. $7600–$8000. (*b*) Research engineer, to conduct air technical intelligence research and monitor projects pertaining to performance characteristics and technical capabilities of foreign pilots aircraft. F.B.I. clearance necessary. $5400–$6400. Ohio. R-6706.

PROJECT ENGINEER, 35–40, mechanical or aeronautical graduate, eight or more years' experience in design of industrial-plant and power-plant equipment. Knowledge of thermodynamics, for project work on design and layout of wind tunnels. $7200. Missouri. R-6719.

DESIGNER, 30–45, mechanical, preferably experienced in actual engineering design, gas, electric, oil, and industrial furnaces, industrial ovens, driers, etc. Experience with controlled atmospheres, conveyers and various metallurgical operations helpful. Minimum of four to five years in this field desirable. Knowledge of metallurgical, chemistry and heat-transfer problems desirable, to engage in preliminary design and estimating of industrial furnaces, ovens, driers, etc., for a designer, contractor, and builder of these complete lines. Salary open. Ill. R-6641.

VICE-PRESIDENT AND CHIEF ENGINEER, mechanical graduate, 35–60, 15 years' experience in steam-power plant design and operation on thermodynamic and heat-cycle studies, specifications and review designs with steam-power plant design consultants for an engineering and architectural firm. Salary open. Pa. R-6664.

[1] All men listed hold some form of ASME membership.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Sept. 25, 1950, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ABRAMS, WARREN ELLIOTT, Lynbrook, N. Y.
BAILEY, CLARK J., Canton, Conn.
BEHRENS, RICHARD CARL, Westfield, N. J.
BISSMEYER, W., Cincinnati, Ohio
BRIMLEY, DONALD F., Venice, Calif.
BROWNEWELL, GEORGE E., Somerville, N. J.
CAIN, BERNARD M., Schenectady, N. Y.
CARGILL, NEAL W., Boston, Mass.
CLARKE, ROBERT R., Rancagua, Chile, S. A.
CRANKSHAW, J. H., Erie, Pa.
DIJULIO, R. M., Chicago, Ill.
DOWD, J. F., New York, N. Y.
EDMISTER, WAYNE C., Pittsburgh, Pa.
FERNANDEZ, J. A., Bronx, N. Y.
GRAM, ARTHUR JULES, JR., Alliance, Ohio
GREIM, CARL C., Defiance, Ohio
GUIV, KEIKHOSROW, Teheran, Iran
HART, M. C., Toronto, Ont., Can.
HART, R., Ilkeston, Derbyshire, England
HEISING, CHARLES R., Lynn, Mass.
HERNANDEZ, DELOS E., JR., DuBois, Pa. (Rt & T)
HILGEMAN, EDWARD H., Riverside, Conn.
HOCHULI, EDWARD SAMUEL, Richmond Hill, N. Y.
HOFFERBERT, ERNEST C., East Gadsden, Ala.
JACKSON, JOHN ROSS, JR., Chicago, Ill.
JONES, TRECKA R., Tulsa, Okla.
KANNALL, VIGIL F., Beckemeyer, Ill.
KINKADE, THOMAS H., JR., Norwood, Pa.
KOSNER, EDWARD F., Cicero, Ill.
LAUTZ, P. R., San Gabriel, Calif.
MARKLEY, GORDON F., So. Euclid, Ohio
MARSHALL, JOSEPH W., Los Angeles, Calif.
MARTIN, WILLIAM M., Western Springs, Ill.
MCCORMICK, WALTER S., Austinburg, Ohio
MERTZ, CHARLES M., Dearborn, Mich. (Rt & T)
MJELLEM, F. O., Alhambra, Calif. (Rt)
MOODY, CHARLES R., Los Angeles, Calif.
MORRISROE, G. L., Albuquerque, N. Mex.
MORRISON, Wilfred C., Charlotte, N. C.

(*ASME News continued on page 770*)

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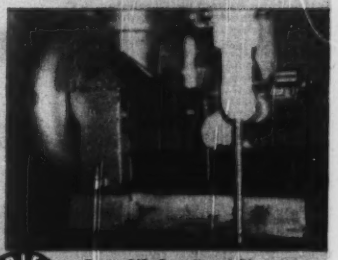
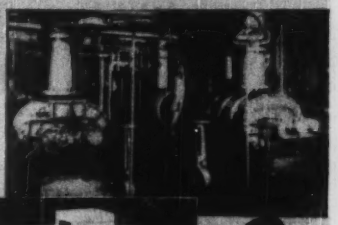


CENTRIFUGAL

Type OIB Centrifugal Blower in food processing plant. Capacity 12,000 cfm. One of several recent installations for this same company in other plants.



ROTARY

(Above) Installation of 4 Type RCB Gas Pumps, used in the manufacture of dry ice in large midwestern plant. Capacity of each pump is 5,270 cfm.

(Below) Small Rotary Positive Blower built into forge for maintenance service.

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BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

DOING ONE THING WELL FOR ALMOST A CENTURY

MOTT, BROCK, Tulsa, Okla.
MOWBRAY, A. Q., Jr., Champaign, Ill.
NANKEY, RALPH WALLACE, Lockport, N. Y.
NOAH, RUSSELL V., Milwaukee, Wis.
O'BRIEN, JAMES F., Richmond, Va.
PAGET, RAYMOND ROBERT, Philadelphia, Pa.
PARMAKIAN, GEORGE, Worcester, Mass.
PAUL, K. C. C., Royapettah, Madras, India
PENGELLEY, C. DESMOND, San Antonio, Texas
PLAUT, PETER E., Milwaukee, Wis.
POPPE, WALTER R., Clifton, N. J.
PRATT, C. W., London, England
RAHRIG, THOMAS F., Cumberland, Md.
RENAKER, JOHN N., Dayton, Ohio
RHOADS, ALBERT B., Meadville, Pa.
ROBERTSON, PAUL L., Oak Ridge, Tenn.
RODRIGUEZ, ARTURO ULLOA, Mexico, D. F., Mexico
SARAVIA, R., Francisco, Mexico, D. F., Mexico
SAUER, HERBERT O., Baltimore, Md. (Rl)
SAUNDERS, BYRON W., Ithaca, N. Y.
SCHICKEDANZ, HARLAN J., Levittown, N. Y.
SCHMANSKY, C. R., Detroit, Mich.
SCHMIDLEY, H. L., Chicago, Ill.
SCHRODECK, E. A., El Segundo, Calif.
SPEER, KIM T., Winston-Salem, N. C.
STEIGELMAN, H. E., Baton Rouge, La.
STEVENSON, LOWELL F., Rockford, Ill.
STUART, D. M., Rancagua, Chile, S. A.
STUART, PAUL S., Jr., New Orleans, La.
TANZBERGER, ERIC W., Olean, N. Y.
TRICH, THOMAS W., Baltimore, Md.
VANNAH, SHERMAN, Medford, Mass.
VASSER, GEORGE, Batavia, N. Y.
VENTURA, MANUEL, Mexico, D. F., Mexico
WIRTH, LOUIS F., Jr., Western Springs, Ill.
WITTEMANN, P. W., Ashland, Ky.

CHANGE IN GRADING

Transfers to Member and Associate

BARKLEY, JOHN F., Washington, D. C.
BETTIS, JOHN RANDOLPH, Charleston, S. C.
BILL, ROBERT G., Baltimore, Md.
BITKO, SOL, Brooklyn, N. Y.
BODNAR, JOHN, Bridgeport, Conn.
BROOK, JOHN EDISON, Webster Groves, Mo.
CHADHA, NARANJAN SINGH, East Punjab, India
DUFFY, THOMAS J., New York, N. Y.
GRAY, HENRY C., Wauwatosa, Wis.
HALLOCK, RICHARD W., Scotia, N. Y.
HARDING, Walter L., New York, N. Y.
HAZARD, HERBERT R., Columbus, Ohio
HERRANK, EUGENE F., Urbana, Ill.
HIGGINS, BRADLEY C., Worcester, Mass.
IPSEN, PETER G., Schenectady, N. Y.
MORGAN, DONALD K., Bethesda, Md.
NOLING, PETER ROBERT, Rockford, Ill.
ORMSTON, ALFRED J., St. Petersburg, Fla.
POND, RICHARD K., Fanwood, N. J.
PANABAKER, D. DRANE, Hamilton, Ont., Can.
SIMMANG, CLIFFORD M., Austin, Texas
WILLIS, ARTHUR C., Dallas, Texas
WILSON, R. C., Massillon, Ohio
WYNKOOP, N. O., Jr., Shaker Heights, Ohio

Transfers from Student Member to Junior 250

ASME Master-File Information

(Not for use of student members)

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Home address . . . . . ☐ (Street — City — Zone — State)

Name of employer . . . . .

Address of employer . . . . . ☐ (Street — City — Zone — State)

Product or service of company . . . . .

Title of position held . . . . .

Nature of work done . . . . .

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Notify headquarters promptly of changes

Obituaries

Almon Lee Beall (1890–1950)

ALMON L. BEALL, assistant chief engineer, Wright Aeronautical Co., Wood-Ridge, N. J., an authority on aircraft fuels and lubricants, died in his home at Packanack Lake, N. J., June 17, 1950. Born, New York, N. Y., March 31, 1890. Parents, Francis Wilson and Luella (Hopkins) Beall. Education, attended Columbia University; ICS courses. Married Mary Walrad, 1914. Author of several technical papers. Inventions: design welding jigs and fixtures, single-cylinder gasoline engine (ind.). Mem. ASME, 1930. Served on ASME Special Research Committee on Lubrication. Survived by wife.

Ralph Cranson Bird (1886–1950)

RALPH C. BIRD, sales engineer, Williams Patent Crusher and Pulverizer Co., St. Louis, Mo., died May 16, 1950, at Jackson, Miss. Born, Highland, Mich., March 28, 1886. Parents, Clayton J. and Lucy (Marshall) Bird. Education, BS, Michigan State College, 1906. Married Louisa Fowler Taylor, 1908. Mem. ASME, 1922. Survived by wife and two children, Ralph C., Jr., and Elizabeth Jo.

Robert L. Cornell (1888–1950)

ROBERT L. CORNELL, consultant mechanical and refrigeration engineering, acting president, Florida Precooling Co., Sanford, Fla., died Feb. 24, 1950. Born, New York, N. Y., May 21, 1888. Parents, George B. and Eleanor E. (Jackson) Cornell. Education, high-school graduate; special courses. Married Marguerite Doll, 1911; children, Anna Lorraine, Marguerite Elizabeth, Robert L., Jr. (Jun. ASME). Author: "Vegetable Conditioning Method and Machine." Mem. ASME, 1927. Survived by wife and three children.

Russell Gardiner Davis (1894–1950)

RUSSELL G. DAVIS, executive, Chain Belt Co., Milwaukee, Wis., died May 13, 1950. Born, Oshkosh, Wis., July 4, 1894. Parents, George Burton and Grace (Gardiner) Davis. Education, BS, University of Wisconsin, 1921. Married Roberta Newman, 1938; children, Russell G., Jr., Preston H., George R. Jun. ASME, 1921; Assoc. Mem, 1925; Mem. ASME, 1935.

Charles Iven Day (1882–1950)

CHARLES I. DAY, engineer, president of W. and L. E. Gurley Co., Troy, N. Y., died June 22, 1950, at the Samaritan Hospital, Troy, N. Y., after a long illness. Born, Damariscotta, Me., Jan. 23, 1882. Parents, George Oliver and Charlotte M. (Hodgkins) Day. Education, BS, University of Maine, 1904; ME, Cornell University, 1905. Married Isabelle Merry Chapman, 1908. Jun. ASME, 1910; Mem. ASME, 1925. Survived by wife and son, Lawrence C.; and a grandchild.

Frederick Lester Jefferies (1875–1949)

FREDERICK L. JEFFERIES, retired general manager, Argo plant, Corn Products Refining Co., died at his home in La Grange, Ill., Nov. 19, 1949. Born, Glen Cove, L. I., N. Y., March 14, 1875. Parents, Robert and Sarah Jane (Seaman) Jefferies. Education, public schools; ICS. Married Genevieve Kennedy, 1916. Jun. ASME, 1900; Mem. ASME, 1905. Survived by wife.

Charles Clifford McDermott (1891–1950)

CHARLES C. MCDERMOTT, president and treasurer, McDermott Water Heaters, Inc., Trenton, N. J., died May 23, 1950. Born, Princeton, N. J., Sept. 19, 1891. Parents, Charles and Jennie (Anderson) McDermott. Education, public schools and correspondence courses. Married Frances M. Sterne, 1936. Mem. ASME, 1931. Author: "Pyrometry." Survived by wife.

Jared Plum Morrison (1876–1950)

JARED P. MORRISON, consulting engineer, Redondo Beach, Calif., died April 16, 1950. Born, California, Mo., June 28, 1876. Education, high-school graduate. Mem. ASME, 1916.

David Barnes Perry (1873–1950)

DAVID B. PERRY, vice-president, Morse Chain Co., Ithaca, N. Y., died at his home, June 15, 1950. Born, Ithaca, N. Y., Nov. 15, 1873. Parents, William H. and Matilda (Barnes) Perry. Education, Ithaca High School; Pratt Institute. Married Elizabeth C. Hall, 1901 (died 1945). Married 2nd, Alice M. Hoyt, 1946. Held many patents pertaining to chain drives and related equipment. Mem. ASME, 1926. Survived by wife; a daughter, Mrs. Dorothy P. Livermore, Rochester, N. Y., and a son, David S.; and a grandson.

Terrell Hamilton Walker (1883–1950)

TERRELL H. WALKER, executive engineer Combustion Engineering-Superheater, Inc., died June 9, 1950, in Roosevelt Hospital, New York, N. Y. Born, Newport News, Va., Sept. 10, 1883. Parents, William and Maria Donna (Terrell) Walker. Education, BSME, Virginia Polytechnic Institute, 1904. Married Beatrice Sargent, 1908. Mem. ASME, 1944. Survived by wife and son, Terrell H., Jr.

Harald Malcolm Westergaard (1888–1950)

HARALD M. WESTERGAARD, former dean, Harvard Graduate School of Engineering and Gordon McKay professor of civil engineering, died June 22, 1950, at Mt. Auburn Hospital after a long illness. Born, Copenhagen, Denmark, Oct. 9, 1888. Parents, Harald Ludwig and Thora Alvida (Koch) Westergaard. Education, BSCE, Royal Technical College (Copenhagen), Denmark, 1911; Honorary Dr. Techn., 1926; University of Gottingen, 1913; Technische Hochschule, Munich, 1914; Dr. Ing., 1925; PhD, University of Illinois, 1916; honorary DSc, Lehigh University, 1930. Naturalized U. S. citizen since 1920. Married Rachel Talbot, 1925. Received the Wason Medal, 1922; J. J. R. Croes Medal, ASCE, 1934; Thomas Fitch Rowland Prize, 1949. Contributed many papers to technical journals and publications. Mem. ASME, 1939. Survived by wife and two children, Mary and Peter

Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

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ASME NEWS

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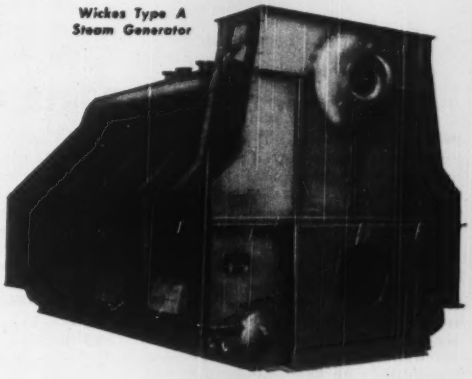
Wickes Type A Steam Generator



WICKES

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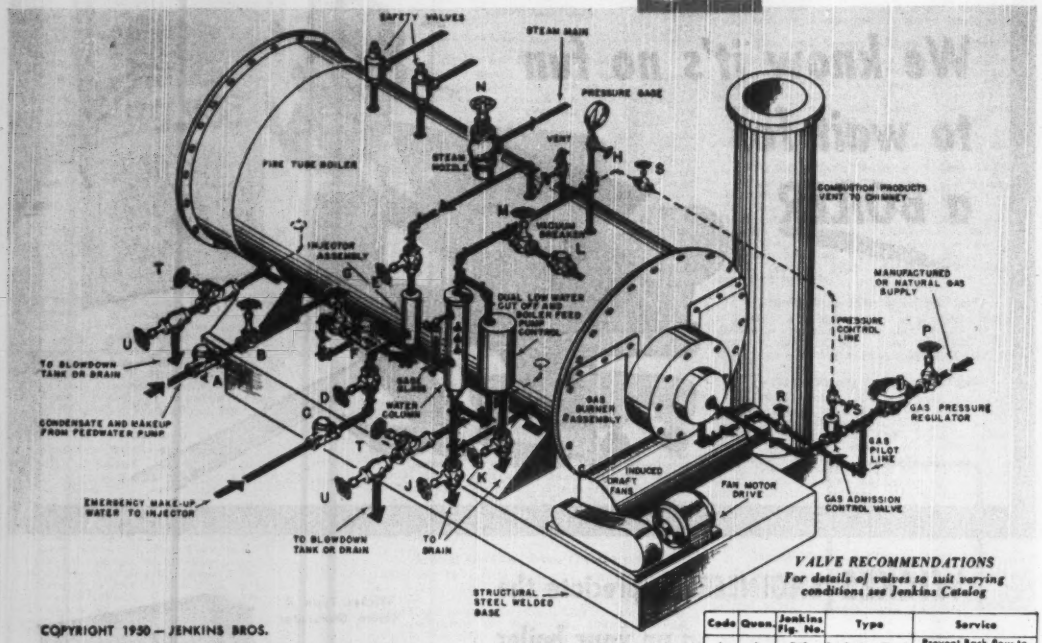
JENKINS PRACTICAL PIPING LAYOUTS 52



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VALVE RECOMMENDATIONS
For details of valves to suit varying conditions see Jenkins Catalog

Code	Quan.	Jenkins Fig. No.	Type	Service
A	1	762	Br. Swing Check	Prevent Back flow to Boiler Feed Pump
B	1	49	Br. Gate	Feedwater Shutoff
C	1	762	Br. Swing Check	Prevent Back flow to Emergency Make-up
D	1	950	Br. Globe	Emergency Make-up Manual Control
E	1	956	Br. Globe	Control Steam Flow to Injector
F	1	762	Br. Swing Check	Injector Mixture to Boiler
G	1	950	Br. Globe	Emergency Make-up Admission to Boiler
H	1	741-G	Br. Needle	Pressure Gage Control
J	1	956	Br. Globe	Water Column Blowdown
K	1	956	Br. Globe	Blowdown Control
L	1	756	Br. Lift Check	Vacuum Breaker Air Admission
M	1	950	Br. Globe	Vacuum Breaker Shutoff
N	1	925	I.B.B.M. Angle	Steam Nozzle discharge
N	1	293	I.B.B.M. Angle S & C	Where 2 or more boilers feed one system
P	1	370	Br. Gate	Gas Shutoff
R	1	741-G	Br. Needle	Gas Pilot Shutoff
S	2	741-G	Br. Needle	Pressure Control Line Shutoff
T	2	124	Br. Blowoff	Blowdown assembly
T	2	297	I.B.B.M. Blowoff	Blowdown assembly
U	2	952	Br. Angle	Blowdown assembly
U	2	615	I.B.B.M. Angle	Blowdown assembly
V	1	741-G	Br. Needle	Boiler Vent Valve

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Two means of boiler feed are provided, the normal feed from condensate return and the emergency feed by means of a manually operated steam injector. A dual low water cut-off and boiler feed control is provided with float and electrode type cut-offs and boiler feed control for maintaining constant water level incorporated in a single unit.

The failure of feedwater from the normal source would cause this dial unit to cut off the fuel supply and sound an audible alarm. If boiler operation is required immediately, cold water make up can be introduced through the manually operated steam injector.

Consultation with accredited piping engineers and contractors is recommended when planning major piping installations.

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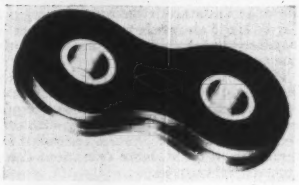
• NEW EQUIPMENT

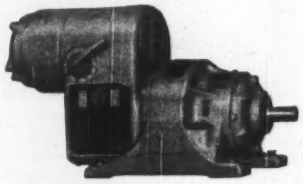
New Connecting Links for Diamond Roller Chains



A patented bushed center plate Connecting Link has been developed for use with Diamond multiple-strand Roller Chain for severe service. This Connector made by Diamond Chain Co., Inc., Indianapolis, provides durability, closely matching that of the Diamond press-fit center plate multiple-strand chain. The same ease of connecting and disconnecting the chain is thus provided as with slip-fit center plate design links thus simplifying the handling of multiple-strand chains. The new Connectors which are being produced for $^{3}/_{4}$ inch through $2^{1}/_{2}$ inch pitch Diamond multiple-strand Roller Chains, have file-hard bushings pressed into pitch holes of pairs of center plates making one unit with the bushings then ground for hole and pitch accuracy. Since full support is provided across all strands and both pins and bushings are hardened and polished, wear is greatly reduced.

New Combination Geared Variable Speed Motor

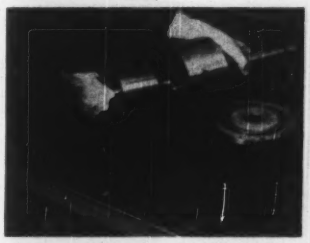
For users of fractional horsepower motors, a new design has been developed by U. S. Motors. It combines in one unit a Varidrive which permits instant change of speed in a ratio of 1 to 10 and a heavy duty Syncrogear for increasing the torque. It is U. S. Motors' Type VA-GD and is available in $^{1}/_{4}$, $^{1}/_{2}$, $^{1}/_{2}$ and $^{3}/_{4}$ h.p. The model is more compact than previous types. Speed ranges are from 10 to 10,000 rpm.



The motor was designed for those fields of operation where a light weight industrial motor is needed. The frame of the Varidrive is cast aluminum. A new type of dial control permits instant speed change by turning the handle less than one revolution to obtain any speed change. Slippage is prevented by incorporation of the improved Autotaut belt tensioner which automatically compensates for various loads. The gears of the Syncrogear unit are specially designed and have a hardness of $^{45}/_{50}$. Rockwell C. Quick inspection of the interior is made by slightly loosening four screws and removing the cover plate. The motor is lower in price than previous types. For details write U. S. Electrical Motors Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.

G-E Magnetic Fluid Clutch

A liquid which can instantly change to a solid and then return to a liquid again is the basic feature of an improved magnetic-fluid clutch built by General Electric Co. engineers, according to a recent announcement. Only six inches long and six inches in diameter the device is capable of carrying enough power to lift one ton 1,000 feet per minute.



The G-E magnetic-fluid clutch is still in the laboratory stage, it was emphasized, and commercial possibilities have not yet been explored.

The magnetic-fluid clutch was developed in the G-E General Engineering and Consulting Laboratory at Schenectady. Consisting of two metal cylinders, each able to rotate independently on the same axis, the clutch transmits rotary power from its source to its load. The cylinders are separated by a magnetic mixture of oil and finely-divided iron powder.

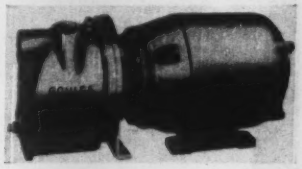
When the unit is energized, the fluid instantly solidifies, making a rigid connection between the two cylinders, so that as one cylinder revolves, its motion is transmitted to the other.

Power can be applied to the load and removed from it easily by the clutch operator. Degrees of rigidity of the magnetic fluid can be obtained by regulating the current, so that the clutch can be allowed to slip if necessary.

Kenneth E. Wakefield and Mason Kronick, development engineers, worked with the same basic type of clutch developed by the National Bureau of Standards. They have equipped their model, however, with rectangular teeth on the surfaces of its clutch faces. The G-E engineers have found that their small clutch, equipped with teeth, will carry a heavier load than one not so equipped.

Goulds Offers Unusual New Self-priming Pump

Goulds Pumps, Inc. in Seneca Falls, New York, announced an unusual new line of self-priming centrifugal pumps.



These new pumps give unique advantages in self-priming applications—for example, all valves are eliminated by the unusual design.

The list of other advantages reads like an engineer's dream of what a self-priming pump ought to be:

Positive self-priming, no large and bulky priming reservoir, no recirculation of water during pumping stage, and efficiencies comparable to standard centrifugal pumps.

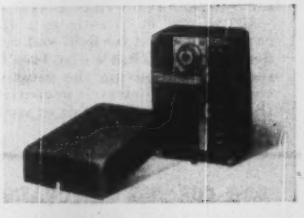
Patents are pending on the new design. Made in sizes from $^{1}/_{4}$ H.P. to 5 H.P., open and closed impellers. Capacities to 120 G.P.M. and heads to 135 feet depending on capacity. Suction lifts up to 25 feet.

For more complete information, write Goulds Pumps, Inc., Seneca Falls, N. Y. Ask for Bulletin 636.1.

New Electronic Timer Announced by G. E.

A new, compact electronic timer which provides automatic control of operation, limit, and sequence timing for literally thousands of industrial processes has been announced by General Electric's Control Divisions.

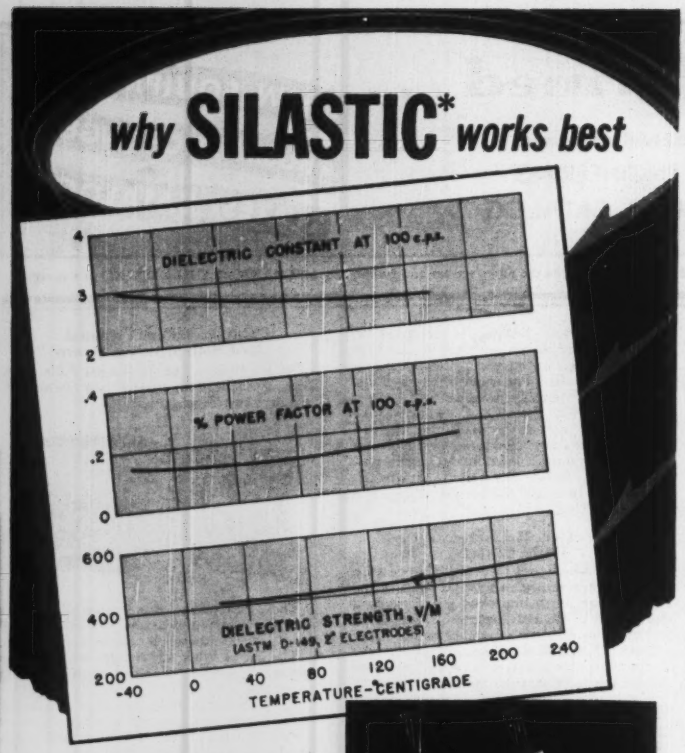
According to G-E engineers, the new timer was designed to fulfill industrial requirements for flexibility of application, accuracy and reliability in operation, low maintenance, and simplicity in servicing. It is available in three time ranges: .06–1.2 seconds, .6–12 seconds, and 6–120 seconds.



Some applications of the new device are: (1) operation timing to control duration of such processes as paint spraying, car washing, photoprinting, electroplating, and heat treat-

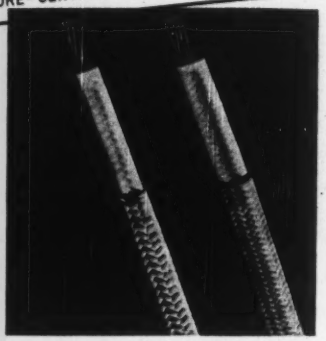
Continued on Page 42

why SILASTIC* works best



as a dielectric material from −100° to +500°F.

Over that wide temperature span only Silastic, the Dow Corning Silicone Rubber, remains resilient and retains high resistance to weathering, moisture, oxidation and ozone. Add good dielectric properties to those advantages and you have the reasons why Silastic is an excellent insulating material for high temperature, high voltage cable and for use in equipment where mechanical breakdown limits the effectiveness of resinous insulating materials.



Silastic is extruded over wire and cable ranging in size from No. 22 to 500,000 circular mils to provide insulation at temperatures from −80° to 400° F.*

Many engineers are familiar with Silastic as a remarkably heat stable and oil resistant rubberlike gasketing and sealing material for use between −100 to 500° F. Silastic as a dielectric for ignition and intercommunication cable and for field and armature coils is, however, a relatively new development. That's why Dow Corning has made available reprints of a recent article giving the most up-to-date information on the physical, chemical and dielectric properties of Silastic. To receive your copy, phone the nearest branch office or write for Reprint No. Q-21.

*T.M. REG. U.S. PAT. OFF.

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FIRST IN SILICONES

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ing; (2) limit timing to stop conveyor belts if material piles up; and (3) sequence timing with two or more timers in combination to control duration of operations on bearing-grinding machines, rod-coiling machines, commercial potato-peeling machines, centrifuges, illuminated signs, etc.

The new timer features a detachable back plate which mounts directly on a rigid conduit or any flat surface. Wires are brought to the back plate and pulled through, and the timer is then mounted on the plate by means of four screws. Wiring to the terminal boards completes the installation. Space between the terminal board and the cover provides adequate room for all front-connected wiring, including that for the accessories. In addition, a dual set of contacts on the timer permit control of two operations on the same time schedule.

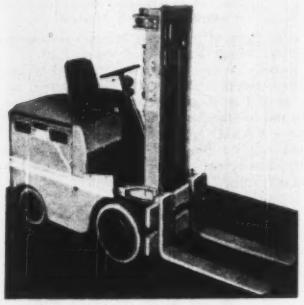
Mechanical wear is cut to a minimum with the electronic device, engineers said, because the relay armature is the only moving part. The G-E 6J5 electronic tube in the timer is a standard model readily obtainable at most radio stores.

Life tests conducted by G.E. indicate that the new timer can perform a million or more operations at these controlled load requirements: inrush—15 amps, carry—10 amps, and break—5 amps. As the controlled load demand is reduced, more operations can be expected, it was said.

Compactness and Maneuverability Distinguish New Clark Fork-Truck

Unprecedented compactness and maneuverability resulting from reduced over-all width and increased speed are among the major features of its new 3,000-lb.-capacity Electric "Carloader" fork-lift truck, according to an announcement by the Clark Equipment Co.

Among the other points of this new machine which are highlighted in the announcement are: controls insuring complete safety; ease of operation; and automatic acceleration, providing smooth and even variations of motor speed. The acceleration is accomplished through a master power-switch regulated by an automatic timer. Driving is almost identical with that of an automobile equipped with automatic gear-shifting device.



The steering-column directional control lever of the new Carloader engages the first point of power for either forward or reverse operation. Controls are the non-plugging type which prohibit change in the direction of travel until the motor comes to a full stop.

Absolute safety is insured, the Clark announcement claims, by simultaneous action of the directional control-lever lock and a "dead-man" brake. The lever locks in neutral, and the brake, operating off the drive-

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shaft, sets automatically when the driver leaves his seat.

Another salient feature of this new truck is a separate motor which powers the hydraulic pump, and which provides lifting and tilting power and speedwell above user needs determined by careful survey. A newly-designed lift-control lever operates in the direction of required action. When the lever is pulled straight up the forks rise; when it is pushed straight down, the forks lower.

Lift heights are available in a range from the standard 84 inches with over-all height of 61 inches with forks down, to 130 inches and an over-all height of 84 inches with forks down. Uprights of rolled alloy steel give unmatched strength to the lift assembly. Hi-Lo Stack uprights are optional.

Easy accessibility to vital parts facilitates service and maintenace.

Standard tires are cushion-type.

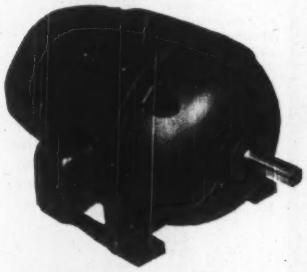
This latest addition to the line of Clark gas-and-electric-powered fork-lift trucks is a completely new machine developed at the request of many Clark customers who have need of a 3,000-lb.-capacity, 24-in.-load-center fork-lift truck with greater maneuverability and speed than was formerly available. It incorporates all those time-tested and proved features of construction which characterize Clark products. Complete, detailed information and specifications may be secured from the Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

This new model is available for export sale.

G.E. Announces New Tri-Clad* Single-Phase Motor

For use where a constant-speed high-torque single-phase motor is required in large ratings, a new repulsion-induction motor has been announced by General Electric's Small and Medium Motor Divisions. An addition to the company's Tri-Clad line, the new motor combines the high starting torque of the repulsion motor with the constant-speed characteristics of the induction motor.

Designated as Type SCR, the motor is available in 5-, 7½-, and 10-hp ratings, all 1800 rpm. The 5-hp unit operates on 115/230 volts, while the other two use 230 volts.



Typical applications include air and refrigeration compressors, pumps, stokers, floor surfacers, and farm uses such as barn hay curing, wood sawing, silo filling, cold storage, feed grinding, etc.

According to G-E engineers, the new motor features high starting torque and low starting current with positive operation on low voltages, making it well adapted for severe starting duty.

The motor is of the open (dripproof) type, and has many features that contribute to long life and aid in installation and maintenance, the engineers said. Tri-Clad construction affords triple protection against

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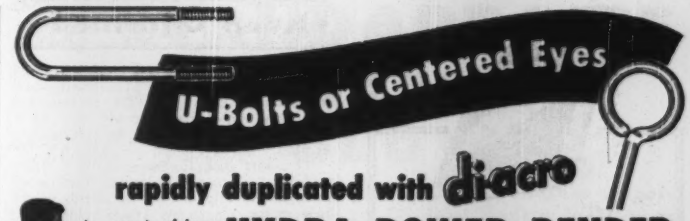

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HYDRA-POWER BENDER

At last—a PRODUCTION BENDER that "BENDS THEM ALL" — tubing — angle — channel—extrusions—moulding—strip stock—bus bars—and of course, all types of solid materials. U-Bolts and Eye-Bolts are just two examples of the shapes that can be rapidly produced in one operation with this hydraulic power bender.

The DI-ACRO HYDRA-POWER BENDER can be easily set up in your own plant for a great variety of forming operations, or it can be delivered completely tooled for speedy production of a specialized part. Investigate this universal machine before you buy any "single purpose" bender.

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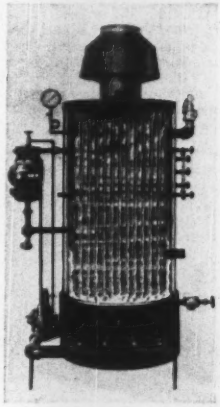

The Kane Boiler is built to ASME specifications, in sizes to 30 H.P.

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Engineered Steam at its best with four decades of experience at your disposal—so, send your steam problem to us for study and recommendation.

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By J. KENNETH SALISBURY, General Electric Company

Just published—this is the *only* steam turbines book written by a practicing designer who is currently working for a large manufacturer. It presents, in easy-to-understand terms—free from "deep" theory—the essentials of steam design of turbines.

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The first part of the book presents the fundamentals of thermodynamics, cycle theory, and flow of fluids. Practical new short-cut methods are included. The author discusses the determination of steam rates at partial load, first explaining the conventional method, and then presenting the short-cut method, together with all necessary curves and data required for its use.

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physical damage, electrical breakdown, and operating wear and tear. The sturdy cast-iron frame has a damping effect on noise and vibration, and covers are easily removed to facilitate inspection and maintenance of brushes.

To assure good alignment between stator and rotor, engineers said, the ball bearings are mounted directly in the end shields of the new motor. Improved brush holders give good brush stability, and brushes and rigging are easily serviced. Efficient cooling is provided by a single large-diameter cast-aluminum fan.

*Reg. Trade-Mark

New Sling Chain Adjuster for Unbalanced Loads

American Chain Division of American Chain & Cable Co., Inc., York, Pa. announces a new idea in lifting loads—the Acco Sling Chain Adjuster. This new device permits the lifting of an object at any angle desired. By shifting the chain in the pocket wheel, one leg is made longer and the other leg shorter. The chain locks and the load cannot shift.

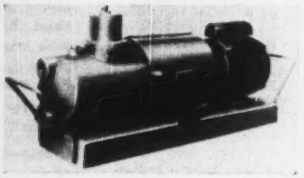
Unbalanced loads, or loads hard to handle can be safely transported using this adjustment, eliminating the necessity of twisting or spiking a leg of the chain to shorten it—a practice that is dangerous and unsafe.

The Acco Sling Chain Adjuster is available only in complete units of pear-shaped link, adjuster and sling chain with hooks on both ends.

For complete information write to American Chain Division of American Chain & Cable Co., Inc., at York, Pa.

New Vacuum Pump for Refrigeration and Air Conditioning Test Work

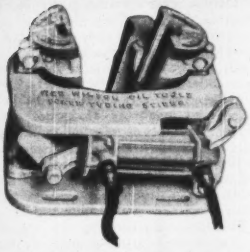
The Beach-Russ Co., 50 Church St., New York, N. Y., announce a new two-stage vacuum pump for dehydrating and testing refrigeration and air conditioning units.



The new unit replaces the old style Beach-Russ Duplex Test Pump which for many years has been the most widely used equipment for testing and dehydrating purposes.

It is lighter and more compact than the old unit, provides a faster pump down and better vacuum, and is much easier to handle and operate. The new pump blanks off at $^1/_{10}$ mm., or 100 microns. It weighs only 80 lbs., and has an over-all length of 28". The pump is driven by a $^1/_3$ horsepower

Ledeen cylinders improve the job



CYLINDER OPERATED OIL WELL TUBING SPIDER SAVES 40% PULLING TIME

Tubing spiders support heavy oil well tubing in the hole while tubing is being screwed together or taken apart. Three sliding wedges, or slips, jamb tubing to support it. Usual operation is by hand, inserting or removing heavy slips as needed.

New power tubing spider requires only two slips and uses a 2" diam. x 6" stroke Ledeen Heavy Duty Cylinder to actuate slips. Motion is positively controlled by foot valve. Unit saves up to 40% of pulling time, replaces extra men.

Standard Ledeen cylinders and mounting attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for New Bulletin 500.

There are Ledeen *Medium Duty, Heavy Duty* and *Super Duty* cylinders for air, oil or water operation ready to help you, wherever you have to push or pull • lift or lower • press or squeeze • tilt or turn • open or close

Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders •

Ledeen Mfg. Co.
1600 San Pedro
Los Angeles 15 Calif.

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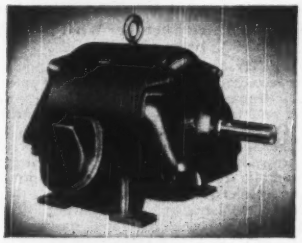
motor with any desired current characteristics. Pump lubrication is automatic.

This new Model A Two-Stage Beach-Russ Vacuum Pump has many other fields of usefulness besides those outlined above. Its ready portability, lightness and ability to handle water vapor at a relatively high vacuum makes it highly suitable for laboratory, pilot plant and field test jobs.

New Splash-Proof Motors

New splash-proof type CSP Life-Line induction motors are available from Westinghouse Electric Corp. These squirrel-cage motors are designed for constant speed applications both indoors and outdoors.



They are fully protected from dripping or splashing liquids by solid rolled-steel frames and baffles in the end brackets.

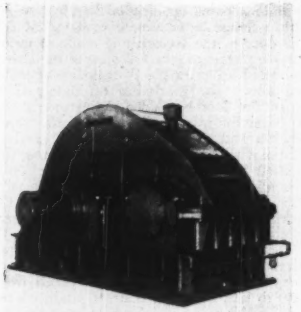
These motors are equipped with prelubricated bearings. No lubrication is required for the life of the bearing.

Typical applications of these motors include food-processing plants, chemical plants, boiler rooms, laundries, oil fields, refineries, and similar places where splashing liquids are frequently encountered. Horsepower: 7½ to 100; Cycles: 60, 50, 25; Volts: 208, 220, 440, 550, 2300; NEMA standard dimensions: Frames 364 through 445.

For further information write Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

New Industrial Speed Reducers

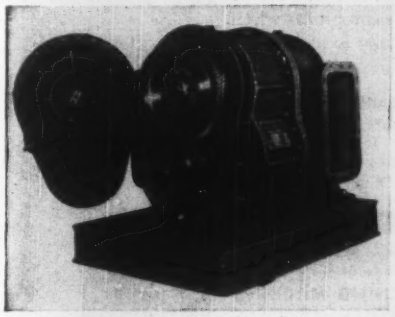
New single- and double-reduction industrial speed reducers in ratings up to approximately 3,000 hp are available from Westinghouse Electric Corp.



BPT taper-hardened gearing and pinion shafts, and fabricated steel housings are used in both types, the WSH and WDH. These features permit units requiring minimum mounting space, and effect substantial savings in weight, compared to units using untreated

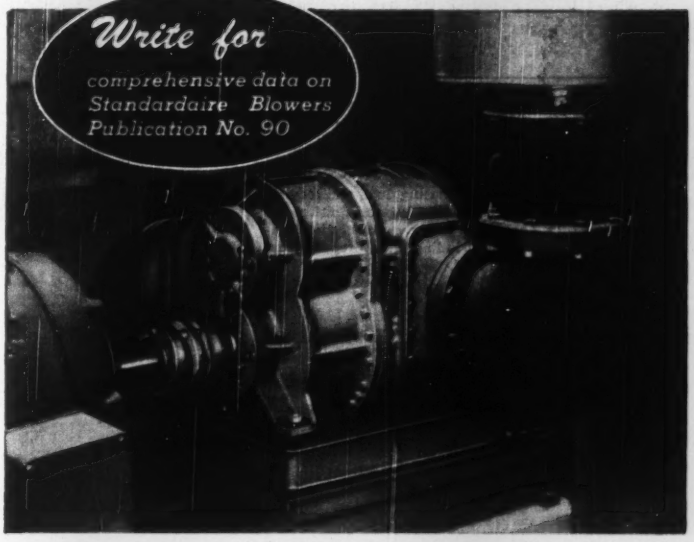
Continued on Page 48

The STANDARDAIRE
PRECISION BUILT
Axial Flow BLOWER ~



Here's another important design feature of the Standardaire Blower —HEAT TREATED ALLOY STEEL TIMING GEARS—generated and shaved to extreme accuracy for quiet operation.

THESE helical gears keep the cycloidal form, screw type rotors of the Standardaire Blower in timed relation. There is no wind-up in the shafts between the rotors and gears as a very small percentage of the in-put power goes through the timing gears. The male or main rotor does the work and consumes the power; the female rotor acts simply as a valve or gate—further evidence of the finer features found only in the Standardaire Blower. The Standard Stoker Co., Inc. Dept. C4—370 Lexington Ave., 17, New York.



● Typical installation of a Standardaire Blower as installed in a melting plant

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Standard Stoker SSS

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Which of these Machines will Save You Money ?

These factory-assembled units of Pangborn Blast Cleaning and Dust Control machines are especially designed to earn extra profits where special equipment is not required.

BLAST CLEANING CABINET
cleans metal parts, removes rust, scale, grime, dirt, paint, etc., in a few seconds. Ideal unit for producing clean, smooth surface on pieces up to 60" x 36".

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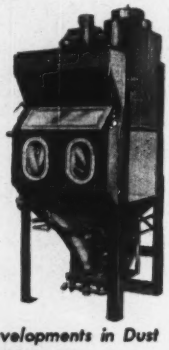
UNIT DUST COLLECTORS $ 260.00 and UP



HYDRO-FINISH CABINET
uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001".

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gearing and conventional cast iron housings.

Gearing is of the standard AGMA hobbed double-helical type, with a high helix angle for smoother operation and less vibration at higher speeds. This type gearing minimizes thrust against either case walls or bearings, and assures uniform tooth loading and wear.

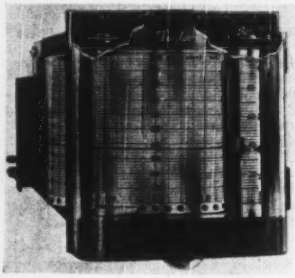
The WSH and WDH design incorporates antifriction bearings throughout, with lubrication by a simple, yet positive splash system. The housings are fabricated of rolled steel sections which form box-type bases. Wide flange I-beams, interlocked and welded, provide maximum rigidity.

For further information, write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

New Miniature Recorder With 3-Inch Strip Chart

The "Transet"* Recorder, a new miniature recording-receiving instrument for pneumatic transmission of flow, liquid level, pressure and temperature, has been announced by Taylor Instrument Companies.

The rapid, wide-spread demand for process information at a central point, requiring pneumatic transmission with conventional sized receivers, resulted in control rooms that became too large and too confusing. The problems thus created pointed the way to "Graphic Panels" and to a small recorder to provide the needed processing data right on the panel itself.



The Taylor "Transet" Recorder answers this need. It is a compact unit, ideally suited for either graphic or conventional panels. It fits into a panel opening of $3\text{-}^{7}/_{8}'' \times 4\text{-}^{1}/_{2}''$ with a flange measurement of $4\text{-}^{3}/_{8}'' \times 5''$. The door of the Recorder is made of clear, durable plastic to give full view of the chart, scale and all principal instrument settings, and allows the maximum of illumination. When the door is opened, adjustments can be made for instant checking of the valve position and for automatic-manual service. Set-point adjustment is made by turning the knurled knob at the bottom of the case. Two micrometer screws above the automatic-manual lever provide a convenient means for making zero adjustments for pen and set-pointer.

The "Transet" Recorder records the transmitter output in terms of the process variable measured. The 3"-wide chart travels from right to left, 1-inch per hour, to produce a record similar to one which would be plotted by an engineer. Charts may be torn off from left side as needed. Electrically driven chart mechanism is designed to pull out like a camera. The scale at the right shows actual process range of the transmitter and graduated 3 to 15 psi for noting valve position and checking calibration.

Four forms (all receivers 3 to 15 psi) are available: (1) one process record, set-point indication, set-point adjustment, valve posi-

• Keep Informed

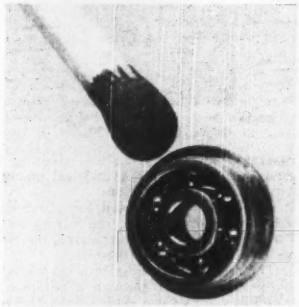
tion indication and automatic-manual unit for use with controllers located in the control house; (2) one process record, set-point indication, set-point adjustment, valve position indication and automatic-manual unit for use with field mounted controllers; (3) one process record, valve position indication and remote manual valve loading; (4) one process record only.

For more detailed information, write for Bulletin 98079, Taylor Instrument Companies, Rochester 1, New York.

* Trade-Mark

Flanged Micro Bearing

Designed to facilitate mounting and assembly, this modern Micro Ball Bearing makes possible substantial manufacturing economies, often permitting substitution of punched sheet-metal housings for expensive, precision-machined castings.



The bearing pictured, catalog #FR1-5, has $^{3}/_{32}$" bore × $^{5}/_{16}$" minor OD × $^{23}/_{64}$" flange diameter and $^{7}/_{64}$" width, with the exclusive "Micro" features of ground OD and outer raceway, not offered elsewhere in the U.S. in miniature bearings.

Other sizes range from 0.55" to $^{3}/_{16}$" in bore, and $^{3}/_{16}$" to $^{6}/_{16}$" in OD, and include both Conrad (retainer) and full-race designs. Dimensional tolerances range from ABEC1 (standard precision ground bearings) to ABEC7, or Ultra-Precision. Standard material is high carbon chrome alloy steel, other specification being available as specials.

Catalog on request to New Hampshire Ball Bearings, Inc., X Key Street, Peterborough 1, N. H.

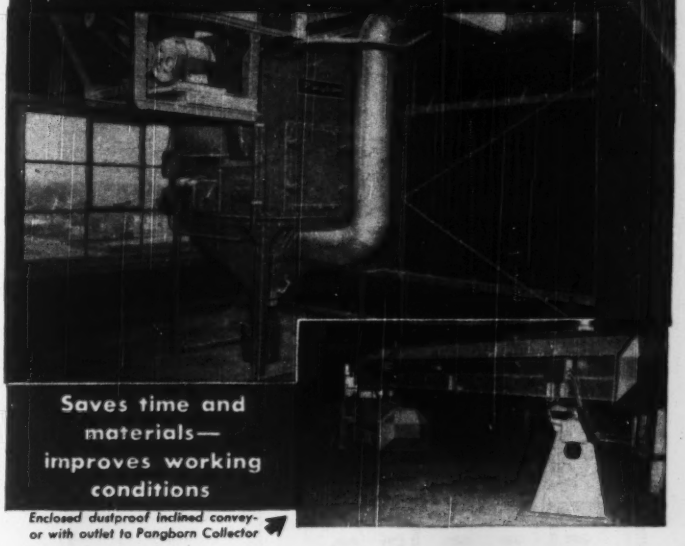
The Clarification and Softening of Cold Water By Sludge Contact Reactors

An old chemical laboratory principle—that previously formed precipitates added in the form of sludge or slurry will accelerate chemical reactions—is utilized in a new sludge contact reactor announced by Cochrane Corporation of Philadelphia. This Cochrane-Liquon Sludge Contact Reactor is designed for such services as: Clarification of Surface Water for removal of suspended solids, turbidity, color, taste and odor for industrial and municipal purposes; Lime or Lime-Soda Softening of any hard water for municipal or industrial application where soft water is desired to save soap, alkali, to avoid scale or deposits in heaters, hot water piping and air conditioning systems, and to aid in the laundering and washing of textiles; Clarification and/or Softening surface and well waters for make-up to cooling towers, spray ponds, etc.; Coagulation and Reduction of Alkalinity of surface or well waters as a pretreatment ahead of ion exchange or hot process softeners for boiler feed; Removal of Silica from water

Continued on Page 48

Pangborn Dust Control

KEEPS AIR "SPRING CLEAN" AT ARMSTRONG CORK CO.



Saves time and materials— improves working conditions

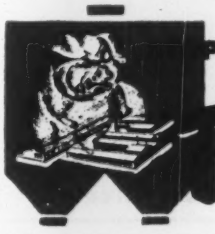
Enclosed dustproof inclined conveyor with outlet to Pangborn Collector

Glass batch mixing and conveying had always been a slow-down operation at the Millville, N. J., plant of Armstrong Cork Co. Fine abrasive dust filled the air, wasting materials and creating unpleasant working conditions for both men and equipment.

When Armstrong engineers designed the new glass batch plant, dust control was naturally included. Now, dust-tight conveyors, hoppers and elevators with PANGBORN DUST CONTROL keep the plant air clear and fresh. Batches are mixed and delivered uncontaminated. Better working conditions have produced top efficiency from both men and equipment.

Perhaps dust control might also increase your plant efficiency —save money, time and materials. Find out now . . . a free Pangborn Dust Survey costs you nothing, and involves no obligation. Write for Bulletin 909A to: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Maryland.

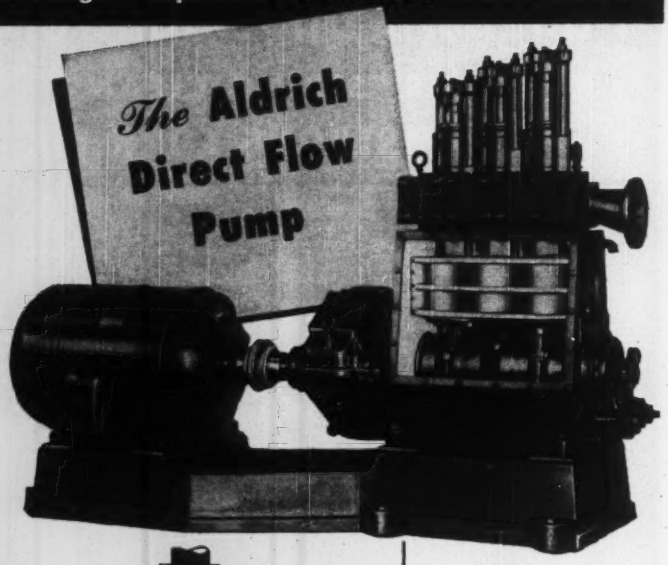
Look to Pangborn for the Latest Developments in Dust Control and Blast Cleaning Equipment

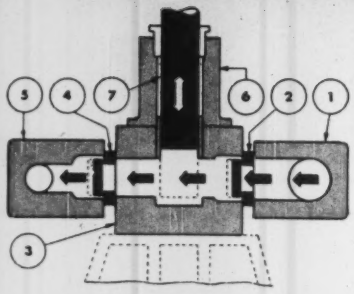


P THE DUST HOG from stealing profits with

Pangborn DUST CONTROL

Design improved . . . cost went down!





Direct Flow Fluid-End Design . . . locating:
(1) suction manifold,
(2) valve assembly,
(3) working barrel,
(4) valve assembly,
(5) discharge manifold,
(6) stuffing box,
(7) plunger.

New to the Aldrich line, this 100 hp reciprocating pump has a through-flow, close clearance design and a sectionalized fluid-end which features extreme simplicity and maintenance economies. One man can easily remove and replace valve assemblies, and fluid-end parts can now be replaced at a fraction of the cost of an entire end unit. Other savings include: interchangeability of wearing parts, less costly pump housing and lower foundation expense. Compared to former units, the price of a new Aldrich Direct Flow Pump is substantially less. Request Data Sheet 64, and check your requirements with Aldrich engineers.

Representatives: Birmingham • Bolivar, N.Y. • Boston • Buffalo • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa

THE ALDRICH PUMP COMPANY

29 PINE STREET, ALLENTOWN, PENNSYLVANIA

Export Dept: 751 Drexel Building, Phila. 6, Pa.

All Aldrich Pumps Have **STAYING POWER**

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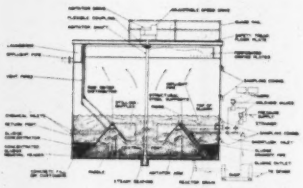
by absorption in contact with ferric hydroxide or magnesium oxide or hydroxides in the sludge to avoid silica deposits in boilers and steam turbines; Removal of Fluorides by absorption in contact with magnesium hydroxides in the sludge; Clarification and De-alkalization of water used for production of carbonated beverages; removal of alkalinity from water used in manufacture of raw-water ice; Iron and Manganese Removal from well waters for municipal and industrial purposes; Separation of Fibre Stock and Filter from White Water in paper mills, permitting the recovery and re-use of this stock as well as the re-use of the treated water; Waste Water Treatment in general to Reduce Pollution of Streams.



Reference to the illustration, showing a typical Cochrane Liquon cylindrical reactor will make clear the operation:

1. Two zones are provided, one above the other in one package unit, the mixing zone below and the clarifying zone above, the two zones separated by inclined baffles.

2. The raw water is uniformly distributed into the mixing zone through a perforated plate located under the ridge of the baffles. After the clarified water separates from the sludge bed it is collected evenly by the off-take system consisting of a circular launderer near the top and at the periphery of the tank or, with large units, a combination of radial and circular launderers. The launderers are provided with submerged orifices designed to withdraw the water uniformly from the system so as to prevent shortcircuiting.

3. The chemicals are introduced at the point where the raw water enters, so that the chemicals, raw water and heavy slurry are mixed simultaneously with minimum of time delay. This is beneficial for rapid reactions in the formation of a well defined floc, eliminating the formation of smaller size floc in the interval.

4. The variable speed agitator across the entire bottom of the Reactor with upright inclined blades insures a uniform slurry mixture, constantly agitated, mixing the chemicals, raw water and sludge intimately and avoiding any deposit on the bottom.

5. The slurry passes upwardly through the central port. Rotation of the mass is stopped by the stilling baffles and the slurry then moves laterally, some of which settles in the sludge concentrators, but the majority of which returns to the mixing zone through sludge recirculation or return ports. Unlike older sludge blanket unit designs, two ports are thus provided, the larger and higher central port for upward flow and the smaller and lower outside port for sludge return. The greater density of concentrated sludge above the return port causes this return flow. A separate path for the return of the sludge to the mixing zone is important, because then it does not have to return downwardly countercurrent to high upflow velocities which prevail through only one port.

6. After passing up through the central port the slurry spreads across the full area of the tank, none of the area being lost by any baffles in the clarifying zone. The slurry bed

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is always carried above the ridge or the crest of the baffles and the water rises slowly, taking advantage of the full area of the Reactor tank. Thus the lowest possible velocity is provided to separate the sludge from the water.

7. The slurry spilling over the ridge of the baffles into the sludge concentrator settles and thickens because it is outside of the zone of agitation and is withdrawn at intervals automatically through a diaphragm-operated valve. The desludging is either controlled by a program timer or proportioned to the raw water flow by connection with the flow meter on the influent line.

8. The duration of the desludging is controlled by a timer which may be manually adjusted. Automatic back-flushing of the perforated sludge collector pipe in the concentrator is also provided to avoid clogging. The back-flushing operation usually precedes the withdrawal operation for a few seconds.

The Cochrane-Liquon Sludge Contact Reactor is made in circular cross section in rolled steel or concrete. Wood construction can also be used. Wood staves pulled up by hoops against a concrete bottom make a simple and inexpensive construction and avoid corrosion. Where concrete straight wall construction is preferred, the unit can be made rectangular.

Bailey "Characterized" Control Drive

A characterized control drive which can be "tuned" to the requirements of a special application is the latest development of Bailey Meter Co., 1026 Ivanhoe Road, Cleveland, Ohio. This completely enclosed air-operated drive makes it possible to parallel characteristics of a driven device with characteristics of other equipment thereby securing a unified system.

The Bailey Control Drive, consists of a double acting air cylinder (with rigid supporting stand and enclosure) a positioning relay, and a manual operating wheel or lever.

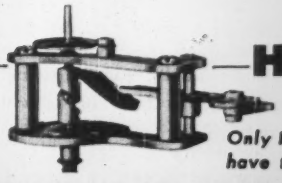
It is the positioning relay which provides the drive's characterizing feature. It incorporates a cam whose shape determines the relation of control drive position to control loading pressure. Three cams are included with each drive and may be used interchangeably to obtain positions which are proportional to the first power (straight line), square, or square root of the control loading pressure. For applications where special relationships are required any one of the three basic cam shapes may be modified easily.

The drive is claimed to be extremely accurate requiring only .10 psi change in control loading pressure to deliver full supply pressure to the piston in the air cylinder. It has

Continued on Page 51

NEW SQUARE, FLUSH CASE GAGE

- ideal for symmetrical panels
- saves space, improves appearance
- 4½", 6" and 8½" dial sizes
- all standard pressure ranges
- with or without internal illumination
- insist on HELICOID GAGES in the new square flush case for that next panel job

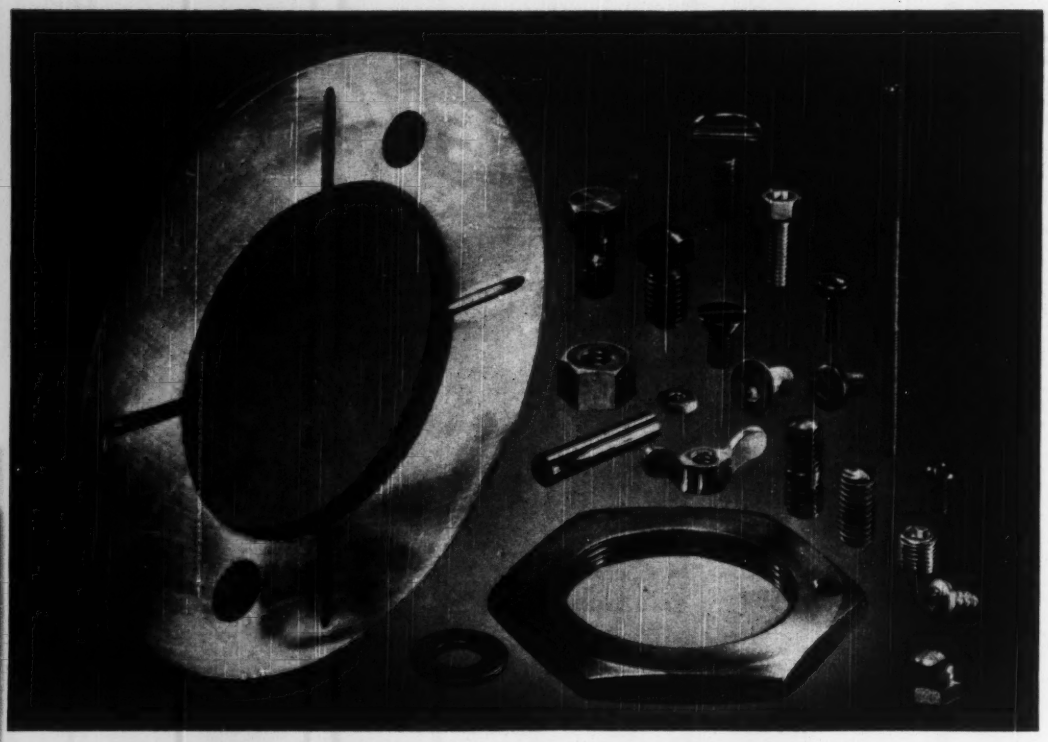


HELICOID

ACCO

Only Helicoid Pressure Gages have the Helicoid Movement

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut



STAMPINGS

From Our Pressed Metal Products Plant

CLUTCH HEAD SCREWS

In addition to CLUTCH HEADS and a complete family of cold headed fasteners. **WE SPECIALIZE IN WASHERS, SHIMS AND BLANKS** from 1/8" in diameter to 13" inclusive . . . produced from .002" to 1¼" thick material.

Thus, with long experience and adequate equipment, **HOLES OF NEARLY EVERY CONCEIVABLE SIZE AND SHAPE** can be held to either commercial or very exacting limits from **STOCK TOOLS.**

Among services not usually offered by stamping plants is United's extended use of secondary operations . . . combining up-to-the-minute heat treating and machining operations with volume production facilities for grinding, tapping and related processing refinements.

For important cost advantages, consider the re-design of your present screw machine, forged, cast or molded parts to the use of flat, formed or extruded stampings.

WE AIM TO CARRY THE MID-WEST'S LARGEST STOCK OF SHEET, STRIP AND PLATE IN LOW AND HIGH CARBON STEEL . . . ALSO IN ALLOYS

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 — CHICAGO 8 — NEW YORK 7

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unusual flexibility; reaction to increased control pressure may be completely reversed by three simple adjustments, and drive travel and loading pressure range can be changed easily and quickly.

Manual operation is simplified by an air supply shut-off valve, a by-pass valve, a hand lever or wheel, and a clamping device.

Bailey Control Drives are furnished in two sizes—one size has a 6" x 8" cylinder (6" bore and 8" stroke) for torque requirements of 280 ft-lb to 400 ft-lb and the other has an 8" x 16" cylinder (8" bore and 16" stroke) for requirements up to 1500 ft-lb.

An outstanding feature of this unique control drive is its steel enclosure which protects the mechanism from damage due to dust, severe weather, excessive moisture, or other deteriorating conditions. The drive is ideal for outdoor power plants, cement mills, foundries, fuming plants, pulp and paper mills, chemical plants, and other process plants.

The enclosure has a modern pleasing appearance which makes easier the important task of good plant housekeeping.

The Du Mont Type 293 Impulse-Test Cathode-Ray Oscillograph

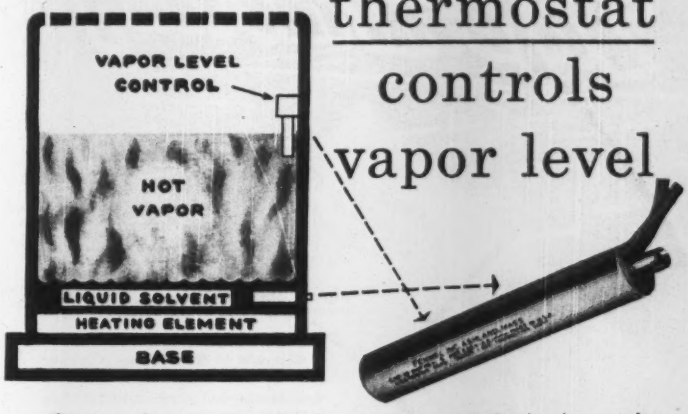
The Instrument Division, Allen B. Du Mont Laboratories, Inc., Clifton, N. J., announces the new Du Mont Type 293 Cathode-ray Oscillograph as an important contribution to the field of impulse-testing of high-voltage transformers, insulators, lightning arrestors, and other equipment designed to withstand surge potentials of great amplitude.

Employing a sealed-off high-vacuum cathode-ray tube and means for convenient external photographic recording, the Type 293 may be used with any standard impulse-test installation. The Type 293 can be triggered by a sample of the test impulse. It also contains a pulse generator to trigger external circuits. An accurate quantitative measurement of the test impulse is provided by metered voltage calibration of deflection along the Y axis of the instrument and time calibration, accurate within 0.1%, along the X axis.

Permanent records are obtained with a specially designed 35 mm oscillograph-record camera employing an f/1.5 coated lens. This camera is supplied as standard equipment with the Type 293. A data card and color-selective mirror are arranged to permit

Continued on Page 52

Multi-purpose thermostat controls vapor level



Once again, THERMOSWITCH® units prove their versatility by performing a dual function for the Cub hot vapor degreaser . . . a product of the Circo Products Co.

These precision thermostats not only control the temperature of the fluid in the degreaser, they *also* control the vapor line level. This latter function has never before been performed by a thermostat and is made possible because of the unusually quick and sensitive response of THERMOSWITCH® units. As a result, vapor level control has been greatly simplified.

THERMOSWITCH® thermostats are unique. Their activating element is a single-metal, external shell that expands or contracts with temperature changes, making or breaking the electric contacts enclosed within it. Used in a wide variety of ways throughout industry, they can be put to work for you. Find out how by mailing coupon today.

Fenwal

THERMOSWITCH®

The Precision, Multi-Purpose, Industrial Thermostat

SENSITIVE... *but only to heat*

FREE! Get this bulletin ... see what Fenwal Thermoswitch units can do for *you*.
Just fill in coupon and mail ... no obligation.

FENWAL, INCORPORATED, 59 Pleasant St., Ashland, Mass.,
111 South Burlington Ave., Los Angeles 4, Cal.
TEMPERATURE CONTROL ENGINEERS

Name ..... *Position* .....
Company .....
Street .....
City ..... *Zone* *State* .....

I am chiefly interested in the applications checked:

☐ Heating
☐ Cooling
☐ Alarm (over-temperature, under-temperature)
☐ Timing (thermal)
☐ Humidity Control or Detection
☐ Vapor Level Control
☐ Pressure Control (by controlling vapor temperature)
☐ Radiant Heat Control

OTHER (Please fill in your special requirements)
.....

Safe-all the Way
One of a series of typical Propane Truck Loading Racks
CHIKSAN Style 50 or 3 Counterbalance Swivel Joint
OKADEE L. P. G. Valve
WECO Wing Union
WECO Hi-Speed Thread Seal

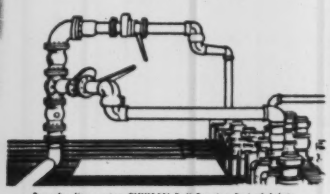
Eliminate *all* the weak spots in your L. P. G. loading racks! Use CHIKSAN *Ball-Bearing* Swivel Joints, WECO Wing Unions, *Okadee* Valves and WECO *Hi-Speed* Thread Seal...and get *matched* safety all the way... plus dependable performance, low maintenance cost, easy handling and long life.

Wherever you handle liquids, vapors or gases through flexible lines, this engineered combination saves you time and money. CHIKSAN Engineers will gladly assist you in designing flexible lines for the safe handling of a wide range of products...in any length...any size...any pressure to 15,000 psi.

REPRESENTATIVES IN PRINCIPAL CITIES

SOLD BY LEADING SUPPLY STORES EVERYWHERE

Play safe *all the way!* Use CHIKSAN *Ball-Bearing* Swivel Joints to make up your loading and unloading lines. With them, you get unlimited flexibility with the strength, long life and safety of steel. You get greater protection...greater safety ...and greater economy with CHIKSAN.



Transfer lines using CHIKSAN *Ball-Bearing* Swivel Joints save cost of extra valves and fittings...eliminate contamination losses.

CHIKSAN ALL-METAL Marine and Barge Hose is easier to handle...safer...and more economical. CHIKSAN Aluminum Hose is lighter, too.

WRITE FOR CATALOG NO. 50

CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY

AND SUBSIDIARY COMPANIES

Chicago 3, Ill. **BREA, CALIFORNIA** Newark 2, N. J.

WELL EQUIPMENT MFG. CORP. HOUSTON 1, TEXAS

CHIKSAN EXPORT CO. BREA, CALIFORNIA NEWARK 2, N. J.

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

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simultaneous viewing and recording of waveforms appearing on the screen of the cathode-ray tube.

Driven, logarithmic sweeps may be initiated from an external signal, internal signal, by manual push-button, or from any point in the cycle of the 60-cycle line voltage. Sweep duration is adjustable in steps from 0.5 to 1000 microseconds. Delay of the sweep with respect to the trigger output of the instrument, is continuously variable from 0.5 to 15 microseconds, permitting detailed display of any portion of the impulse waveform.

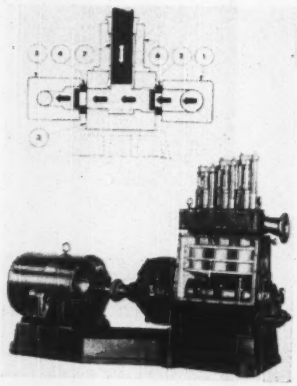
Bandwidth of both the X and Y axes is essentially uniform from d-c to 25 megacycles, assuring excellent reproduction of pulses with high-frequency components. There is no distortion of pulses having a rise time of 0.01 microseconds or greater.

The Type 293 is packaged in a single, compact and mobile console, and is priced inexpensively.

Direct Flow Principle in Pumps Results in Greater Efficiency, Economy

The introduction of the Direct Flow principle in pump design by The Aldrich Pump Co., 29 Pine St., Allentown, Pa., has resulted in numerous advantages, including greater volumetric efficiency and lower operating and maintenance costs.

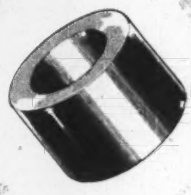
Designed to permit direct or through-flow of liquids, the new Aldrich pump features a major revision in construction. The design resulted in a reduced volume of space between valves which made possible a higher volumetric efficiency. It also employs a sectionalized fluid end, composed of separate units which include the working barrel, stuffing boxes, valve units, plunger, and suction and discharge manifolds.



As shown in the diagrammatic drawing, the suction (1) and discharge (5) manifolds are separate units which are bolted to the forged steel working barrel (3). The valve assemblies (2 and 4) and valve seats, which are held in place by the manifolding, are easily accessible. The stuffing box (6) is removable to permit adapting other size plungers (7) to the pump. Note that the pumping fluid flows through in a direct line, without being diverted. In performance tests, Direct Flow pumps have operated with a volumetric efficiency of 96%. Close clearances give high efficiency with light as well as heavy liquids.

Besides simplicity and accessibility, the sectionalized design of the Direct Flow pump

WORKS WHERE OTHERS WON'T



accurately formed

GRAPHALLOY OILLESS BEARINGS

SPECIFY GRAPHALLOY WITH CONFIDENCE

MADE SOLELY BY U. S. PAT. OWN.

SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — even where oil solidifies or carbonizes ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION

1058 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

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provides a maximum economy of maintenance. Individual fluid end sections can be replaced at a fraction of the cost of the entire fluid end unit. Since almost all of the wearing parts in the Direct Flow Pump Series are interchangeable, only three sets of wearing parts are necessary to cover a total range of Aldrich pump sizes from 100 hp to 2450 hp.

Direct Flow pumps are particularly adaptable to oil industry applications such as primary and secondary recovery, recycling, salt water disposal, crude oil gathering lines and product lines. These pumps are also suitable for handling butane, propane, lithium chloride, diethylene glycol, and other fluids.

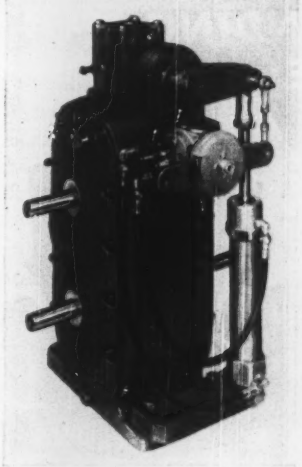
In the general industrial field, Direct Flow pumps are used in plastic molding, metal forming, rubber molding, lead cable extrusion, synthetic processing involving high pressure and other applications requiring central hydraulic systems.

The hydraulic medium handled can be water, soluble oil in water, or hydraulic oil. To control capacity when applied to central hydraulic systems, the pump can be fitted with a by-pass valve to operate automatically with all types of accumulators.

Additional information on Direct Flow Pumps can be obtained by writing to The Aldrich Pump Co., Allentown, Pa.

Automatic Controls for P.I.V. Variable Speed Drives Announced by Link-Belt

A new line of Automatic Speed Controls for the Link-Belt P.I.V. Variable Speed Drive is announced by Link-Belt Co., to meet the growing demand for positive, quick-acting, automatic control of rotary motion throughout the industries.



These new controls are job-engineered for automatically controlling the output speed range of the P.I.V. and are available in four basic types—Electronic, Hydraulic, Pneumatic, Mechanical, as outlined in a new 8-page illustrated Link-Belt Book No. 2349.

The uses for these automatic controls are many, such as the following examples: (A) Separate machines must be kept in accurate synchronization, often over a wide range of operating speeds. (B) Beams, feed rolls, take-up and pay-off reels must be driven at ever-changing, infinitely variable speeds to

Continued on Page 54

FIRST TIME in one book

—ALL known experimental methods for determining mechanical strength

Handbook of EXPERIMENTAL STRESS ANALYSIS

Editor-in-Chief, M. HETÉNYI, *The Technological Institute, Northwestern University.*

Until this book was published, material on experimental stress analysis was scattered and incomplete. Now, technologists interested in the determination of the mechanical strength of structural and machine parts can find all the existing experimental methods in one convenient handbook.

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Thirty-one of the most prominent men in the field—*the men who developed the techniques*—are the contributors.

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August 1950 1077 pages 820 illus. $15.00

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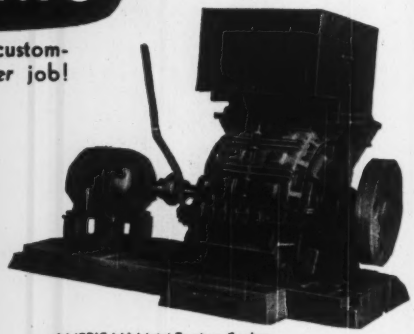

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keep tension constant in drawing, coating impregnating, extruding and laminating materials of many sizes and kinds. (C) Operating cycles of differing lengths must be precisely timed and accurately maintained over varying periods without interruption. (D) Temperature, velocity, pressure, liquid levels and flow of materials must be held to narrow limits despite variations in operating conditions.

Like alert traffic policemen at busy intersections, Link-Belt Automatic Controls regulate the flow of material at critical points, thereby providing the exact speed needed for maximum production.

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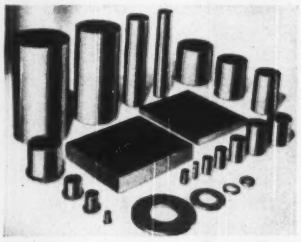
A copy of new Automatic Controls Book No. 2349 containing photographs and operating diagrams of various interesting applications, will be sent to any interested reader promptly upon request.

New Bost-Bronz Oil Impregnated Bearings

Boston Gear Works presents a new line of all-purpose, precision-sized porous bronze bearings, cored bar, solid bar and plate stock in a wide range of stock and sizes in stock for immediate availability at eighty-five Boston Gear distributors throughout the United States and Canada.



The new "Bost-Bronz" Bearings carry their own oil reservoir providing an oil film that is always present on every surface. This not only adds to the wearing quality of the bearing but actually increases its load carrying capacity as the shaft always rests on an oil cushion even when at rest. The constant oil film permits closer shaft clearances and assures quiet, smooth operation. The trouble and expense of machining oil holes or grooves in bearings is done away with.

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"Bost-Bronz" is re-lubricated by simply applying oil to the outer surface. The oil is absorbed by capillary attraction just like a blotter takes up ink.

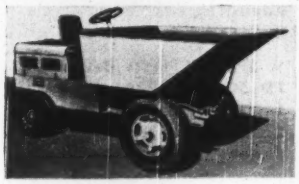
"Bost-Bronz" Bearings make for clean, economical operation as there is no oil drip or waste. Dirt is repelled by the bearing and there are no holes or grooves to permit entrance of grit, lint or dust. "Bost-Bronz" Bearings are easily assembled with any reasonable press fit and will not break or chip. The bore can be sized at assembly simply by using a shouldered arbor. Applied in standard, reamed holes and with standard shafts no machinery is necessary.

"Bost-Bronz" plain cylindrical bearings are stocked in $\frac{1}{8}$" to 3" inside diameters, flanged bearings, $\frac{3}{16}$" to 2" I.D., thrust bearings $\frac{1}{4}$" to $1\frac{1}{2}$" I.D., cored bar stock $\frac{1}{2}$" I.D. × 1" O.D. to 4" I.D. × 6" O.D., solid bar stock from $\frac{3}{8}$" O.D. to 4" O.D., plate stock $\frac{1}{8}$" thick to 1" thick. Machining of "Bost-Bronz" offers no problem, using tungsten carbide or equivalent tools and feeds and speeds for any bronze.

Complete information on "Bost-Bronz" stock sizes, prices, tolerances and load ratings may be found in the new Boston Gear Catalog No. 55, available at any of the eighty-five "Bost-Bronz" distributors or from Boston Gear Works, 66 Hayward St., Quincy 71, Mass.

Clark Announces Newly-Designed Haulage Vehicles

Increased speed, reduced size and greater stability are three of many new features of the redesigned "tructractor" line of haulage vehicles announced by the Industrial Truck Div. of the Clark Equipment Co.



A new two-speed transmission permitting 14 m.p.h. travel in high gear and 8 m.p.h. in low gear, in both forward and reverse, is an outstanding feature of the redesigned "tructractor" line.

A shortened wheelbase, reducing over-all length, has made possible a 12-inch decrease in the turning radius. Yet stability has been increased through the new four-wheel construction and pivoted steering axle. The new "tructractors" can be operated with ease, indoors and out, and even through narrow factory aisles.

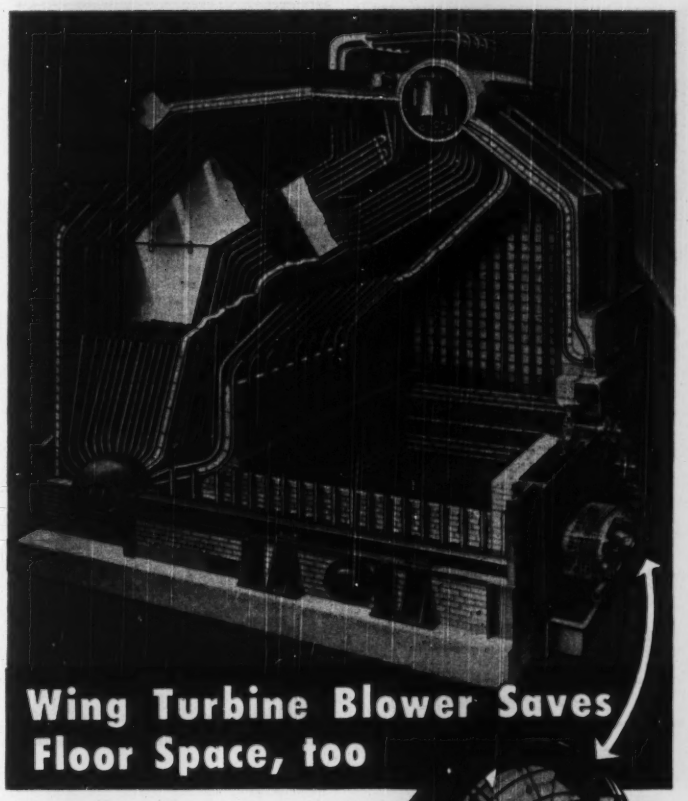
Distributor, starter and generator are enclosed, and spark plugs have rubber covers, making the electrical equipment virtually dust-proof.

Unusual strength in the newly-designed frame is achieved through use of heavy steel channel and plate, cross braced, bolted and welded into an integral unit. All lubrication and maintenance points are readily accessible. A gas tank of increased capacity has been relocated away from the engine compartment. A water pump circulating system assures proper engine cooling.

The "tructractors" are offered in two models, "Tip" and "Dump," each with a bulk-load capacity of up to 40 cubic feet, and weight-carrying capacity of 4,000 pounds.

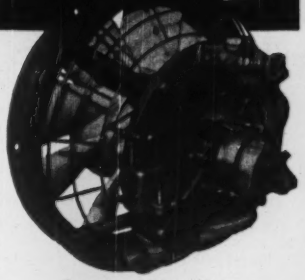
Additional information will be furnished by the Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

Continued on Page 58



Wing Turbine Blower Saves Floor Space, too

Besides furnishing forced draft with precise control, the Wing Turbine Blower contributes to the cost-saving features of the B & W Integral Furnace Boiler, illustrated above, by saving valuable floor space, avoiding duct work and large space requirements. It is also quiet and efficient in operation.



A copy of Wing Bulletin No. SW-50 on Wing Blowers and Turbines will be sent on request.

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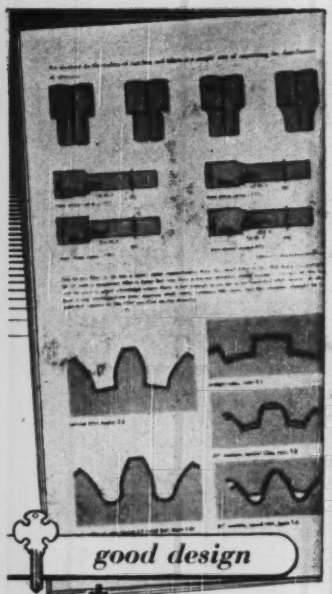

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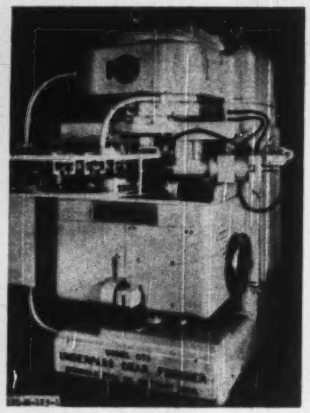
Gears Now Finished Without Removing Them from Conveyor

Ability to finish gears automatically without even removing them—manually or mechanically—from a conveyor is among the latest developments in automation. Developed by Michigan Tool Co., Detroit, the arrangement permits the use of individual or multiple 870 rotary gear finishing machines—operating continuously at peak efficiency. The operator merely places the gears on a conveyor as they come off the previous operation. The conveyor carries them through the finishing operation and returns them to the operator for removal from the conveyor.

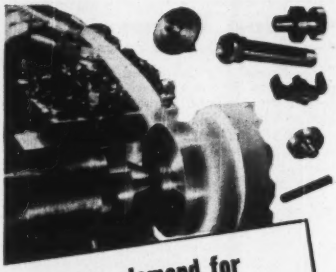


The ingenious idea that made the arrangement possible was the simple one of passing the conveyor right "Through The Machine," instead of passing 'by' the machine in the conventional manner. This presented no difficulties with the 870 finishers since it involved merely the provision of an aperture in the rear of the column for the exit of the conveyor.

Cluster gears can pass—on the same conveyor—through a battery of 870 machines, each of which, in turn, finishes a specific gear in the cluster, the conveyor itself providing the automatic transfer from one machine to the next.

The conveyor is provided with simple spring loaded jaws to hold the gears. To hang a gear on the conveyor, light finger pressure on the top of the jaws opens them. The gear is inserted. Release of finger pressure closes the jaws. Finished gears are removed from the conveyor in the same manner, although automatic release from the conveyor is possible if provision is made to handle the gears automatically after removal in such a manner as to avoid chance of their being 'nicked'.

The conveyor carries the gear into position above the finishing cutter. Air operated centers on the machine now engage the gear (there being sufficient clearance between jaws and gear to permit light movement for alignment by the centers). A mechanical 'finger' now comes down on top of the jaws, separating them and leaving the gear free to 125 move at crossed-axis to the cutter. The machine goes through its cutting cycle and the mechanical 'finger' releases to re-engage the gear in the jaws of the conveyor. The centers retract and the conveyor moves the gear out of cutting position and the next gear into position.



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★ ***SPEEDS, FEEDS INCREASED 50%*** turning, drilling, facing, reaming, tapping forged steel valve bodies (equivalent SAE 1315) on turret lathe after applying Stuart's SOLVOL water soluble cutting fluid concentrate. And, excessive scrap loss due to high finish requirements was eliminated.

★ ***PRODUCTION DOUBLED*** boring 7½" dia. hole through 11" dia. x 30½" long solid forged 5060 steel pump liner through use of Stuart's SPEEDKUT B the multi-purpose cutting fluid.

• These are not isolated examples of how Stuart can help boost production. They are taken from daily field reports. Ask to have a Stuart Representative call. Send for your copy of "CUTTING FLUID FACTS."

D.A. Stuart Oil Co.

2741 S. Troy Street, Chicago 23, Ill.

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The entire operation of indexing, engagement by centers, and release of jaws takes only a matter of 2½ seconds. The gear in the installation shown (14 pitch, 2⅜ in. diameter and ⅞ in. face width) requires only about 17½ seconds to finish, for a total 'floor-to-floor' of only 20 seconds.

All movements of the installation are electrically interlocked and automatically sequenced. If the conveyor should perchance not index to correct position, or centers should not engage the gear properly, or the jaws should not release, the cycle is interrupted.

Thus actually, the conveyor itself controls machine operation and the usual electrical controls on the front of the machine are eliminated. Such push buttons as are required are located centrally at the loading and unloading station for the conveyor.

Sparger Nozzles Cut Tank Heating Costs

Recent installations in industrial plants throughout the country have shown that definite savings can be realized through the use of Sparger Nozzles instead of drilled holes in the Sparger Pipe used in the tank heating of liquids.

Prior to the development of the Sparger Nozzle, pipe replacement presented a costly problem because the drilled holes wore rapidly due to a combination of high steam velocities and corrosion. This rapid wear necessitated constant replacement of pipe and involved considerable expense in materials, down time and labor.

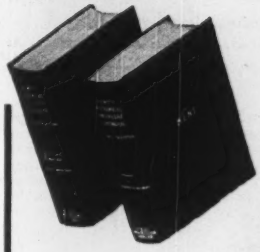
In plants where Sparger Nozzles have been introduced, costs are being cut drastically—the most obvious being in replacement. Before, when holes drilled in Sparger Pipes wore excessively, it was necessary to replace the entire pipe. With Sparger Nozzles, this is no longer necessary since it is a simple matter to thread a new nozzle to the pipe.

Also, in previous installations in which holes were drilled in the Sparger Pipe, the steam could heat the tank liquid only by percolation through the tank. It was practically impossible to obtain uniform tank temperature and the operation was usually accompanied by a loud, cracking noise.

With Sparger Nozzles, steam, issuing from the Sparger Pipe through the tip of the steam nozzle at high velocity, entrains tank liquid through the open area on each side of the nozzle. The steam and tank liquid then enter the nozzle chamber where they are thoroughly mixed and discharged, with sufficient force to cause constant agitation within the tank, which, in turn, gives faster heating, even tank temperature and quiet operation.

As an example of the heating efficiency which can be obtained using Sparger Nozzles, with steam at 183 lb. per hour and 40 psi gauge, one nozzle in a 100 gallon tank will

Continued on Page 58



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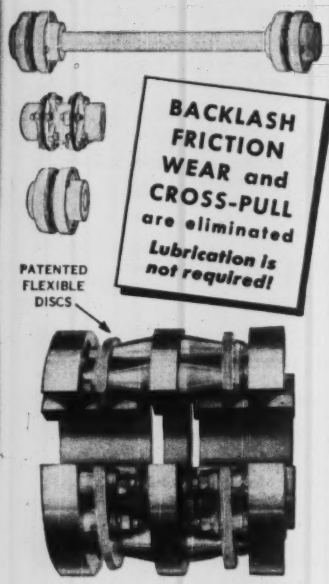

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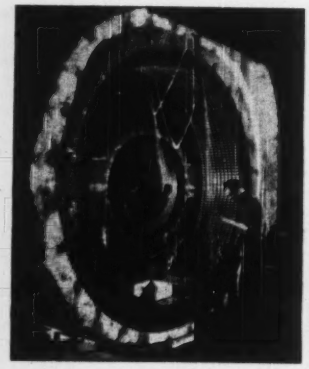
circulate 20 gpm of water and will raise the temperature of the tank liquid 40° in 11 minutes.

To provide for the use of the Sparger Nozzle with various liquids, including those of a corrosive nature, the nozzles are made in bronze, cast iron, stainless steel and Haveg.

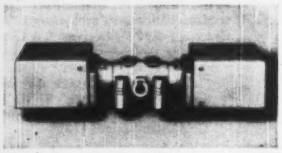
Additional data including information on heating capacity and steam consumption can be obtained by writing to Dept. JB, Schutte & Koerting Company, 1166 Thompson Street, Philadelphia 22, Pa.

Spiderweb Helps to Build Motor for India



Destined to drive pulp grinders in a paper mill in India is this 4000-horsepower motor being built at the East Pittsburgh plant of the Westinghouse Electric Corporation. The web-like arrangement of heavy cords, slip-knots, and hitches enables the workman to lower the heavy copper coils evenly and gently into place in the motor stator without damaging the mica insulation. The large diameter of this motor is required to give the rotor a flywheel effect to overcome heavy shocks encountered in grinding pulpwood that would result in voltage fluctuations on the electrical supply system. Speed of the motor will be 231 revolutions per minute. In the background, another workman uses an air hose on a motor frame with coils already in place.

Rivett Double Solenoid Hydraulic Valve



A new double solenoid operated 4-way hydraulic valve has been announced by Rivett Lathe & Grinder, Inc., Boston, Mass. The new Series 5500 is designed for use as a semi-automatic electric control of a hydraulic circuit. Located at each end of the valve body, the two solenoids are continuous duty push type. Energizing the solenoid on the right moves the valve piston to the left, and vice versa.

Principal feature in the new design of the Series 5500 is the hydraulically balanced piston which has an integral spool and stem. The entire piston surface is hardened, ground

Continued on Page 60

STAINLESS STEEL
WHICH ALLOY FOR YOUR PIPING JOB?

Industry is rapidly turning to stainless steels as standard material for an increasing number of piping applications. Their ability to withstand the action of many corrosive agents, their toughness in sub-zero applications, their strength and ductility in elevated temperatures, and their high scaling-resistant properties, answer many tough piping problems.

Recent surveys show that 95% of the demand for stainless steel piping is in these three types:

Type 304—18% chromium, 8% nickel
Type 347—18% chromium, 8% nickel, 1% Columbium
Type 316—18% chromium, 8% nickel, 2% Molybdenum

Each exhibits inherent qualities that make it ideal for certain applications. Thus, while the group as a whole covers 95% of industry's needs, individual applications should be studied carefully to determine which grade is best for the job.

For example, a prominent soap manufacturer's requirements are 10% Type 304, to eliminate product contamination—45% Type 347, to carry low temperature organic acids—and 45% Type 316, to carry the same acids at elevated temperatures.

In the food and dairy industry, where the service is only mildly corrosive, the main reason for using stainless steel is to promote cleanliness and to eliminate contamination. Type 304 satisfies most of the demand here.

To provide the greater strength, greater safety and permanently leakproof joints of welded piping construction, Tube Turns, Inc. has developed a wide selection of types and sizes of welded fittings and flanges in all three grades of stainless steels listed above. It's the most complete line available today.

TUBE-TURN Stainless Steel Welding Fittings made of the three alloy types listed here, are available in a wide range of parts and sizes, including elbows, returns, tees, reducers, caps, lap joint stub ends, Laterals and crosses. Flanges are also furnished.

NEW CATALOG

Write today for your free copy of the new Stainless Steel catalog, just published by Tube Turns, Inc. It contains the complete description of TUBE-TURN Stainless Steel Welding Fittings and Flanges, as well as valuable information on the use of stainless steel piping.

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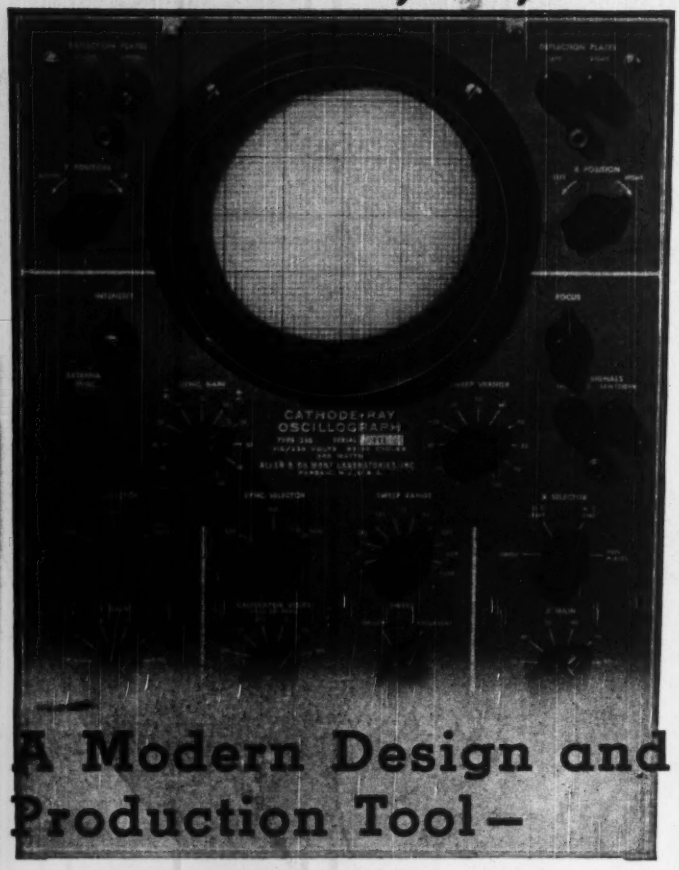

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and lapped with special grooving to minimize possibility of binding under high pressure conditions.

Rivett Solenoid valves are offered in Double Solenoid Operated type with either standard action or spring centered action; Single Solenoid Operated with spring return; and Solenoid Pilot Operated.

Designed for pressures up to 1500 P.S.I., the Series 5500 is available in 5 sizes: $^1/_4$", $^3/_8$", $^1/_2$", $^3/_4$" and 1", for standard 110, 220, and 440 volt, 50 or 60 cycles. Non-standard current specifications furnished upon request.

Catalog Section 202 illustrates and describes the new Series 5500. Write Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass., mentioning this magazine.

Armco Super-thin Magnetic Steel Alloy

Steel so thin it takes ten layers to equal the thickness of a human hair—that's the new product of the Research Laboratory of Armco Steel Corp., Middletown, Ohio.

Need for a super-thin alloy with special magnetic properties came with the development of high-frequency electronic equipment. Navy officials and leading electronic manufacturers asked Armco to produce the material because of the company's long experience in research and specialty steel.

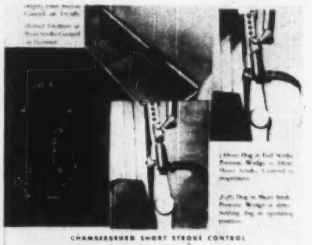
Within five weeks Armco technicians were rolling the alloy on a tiny mill built by them for the job. Work rolls on this mill are only $^5/_{16}$ of an inch in diameter yet they are called upon to support pressures measured in tens of thousands of pounds.

A typical production run starts by cold reducing the alloy on a larger mill to a thickness somewhere between .006 and .002 of an inch. The material is then readied for the final reduction by cutting the footwide metal into two inch strips. After successive passes through the special mill, the alloy has been elongated some 400 times, and reduced in thickness to .00025 (twenty-five hundredthousandths) of an inch.

In order to test the performance of these magnetic alloys, the strip is slit into ribbons one tenth of an inch wide on an ingenious jig which uses razor blades as cutters. The ribbons are then coated, wound into tiny coils, and annealed.

A recent order for four test coils of this ribbon weighed so little that 2250 such orders would yield only one pound of metal. This order was shipped quite securely by first class mail in an aspirin box.

Chambersburg Provides Short or Long Stroke Control on Hammer



CHAMBERSBURG SHORT STROKE CONTROL

The ability to change from full stroke to short stroke or vice versa at the will of the hammerman is provided in the Ceco-Drop Short Stroke Control just announced by Chambersburg Engineering Co., Chambersburg, Pa. This patented device, an air-operated dog attached to the rocker which

• Keep Informed

controls the action of the valve, can be applied to any Chambersburg Ceco-Drop Hammer, 1000 lbs. and up. Pressure on a push button on the treadle changes the stroke. It can be arranged so that the short stroke is the normal stroke, with pressure on the treadle push button changing to long stroke, or it can be arranged so that the long stroke is the normal stroke with pressure on the treadle push button changing to the short stroke. Release of the button reverts to normal stroke. The sequence of blows is uninterrupted. Treadling is simple, natural and practically effortless. Jobs which required a drag on the boards in a board drop hammer can be done better and cheaper in a Ceco-Drop Hammer with Short Stroke Control. There is no drag. Both short and full strokes fall freely.

Baldwin 10,000-Lb. Wire Testing Machine

Tensile tests on samples of all copper line wire produced at Western Electric Company's Hawthorne works, Chicago, are now made on the 10,000-lb. wire testing machine shown herewith. Samples of the copper rod from which the wire is made are also subjected to tests.

Rigid wire specifications are required because electrical conductors hung on telephone poles are subjected not only to their own weight but also to stresses imposed by such natural forces as wind and sleet. This necessitates thorough tests which assure maximum strength and methods of manufacture that eliminate defects.

The testing machine was especially designed by Baldwin Locomotive Works to apply test loads to wire ranging in length from 2 in. to 60 in. between the Templin grips. Loads are applied hydraulically by a ram with a 36-inch stroke. Loading speed may be varied up to a maximum of 25 inches per minute by means of a hydraulic control valve. Maximum return speed is 20 inches per minute. Varying lengths of wire are provided for by six positions of the fixed crosshead on the frame of the machine. The crosshead is held at these points by a 1¼-inch diameter pin.

Loads are accurately measured by means of an independent hydraulic weighing system, using an Emery cell as the load-sensitive unit on the moving crosshead of the testing machine, and a Tate-Emery indicator housed in a cabinet which has been made an integral part of the machine. Accuracy of this system is within 0.5 percent of load or one scale division, whichever is greater. Loads are indicated on a 24-inch diameter dial with 1000 divisions on a 66-inch scale. In addition to the 10,000-lb. range the indicator

Continued on Page 62

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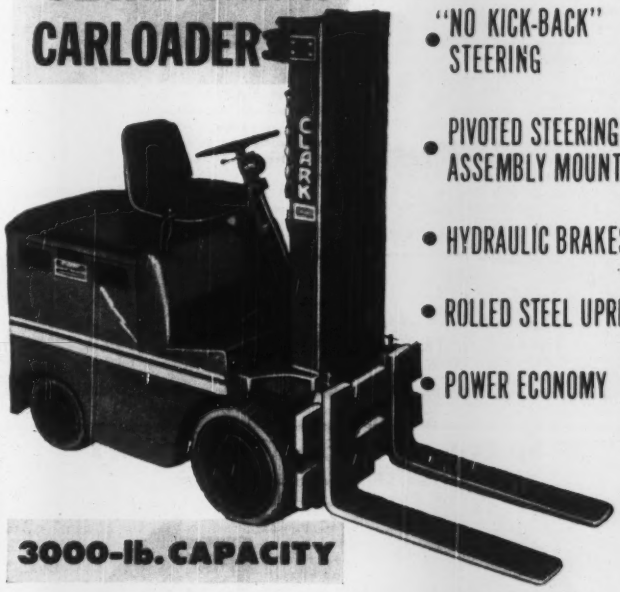
Entirely New CLARK Electric CARLOADER



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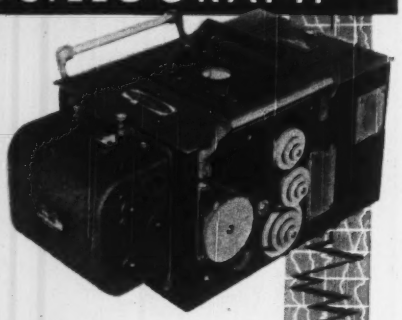
Long the world's most popular oscillograph, the Type S-14 has been redesigned and improved to meet exacting demands of modern research. The NEW Type S-14C 'Economy' Oscillograph is the simplest to operate and maintain, and the most versatile in application. No research or testing laboratory is complete without it.



- Wide range of galvanometer types and characteristics. Natural frequencies to 10,000 cps; sensitivities to 50,000 mm per ma; single and polyphase watts.
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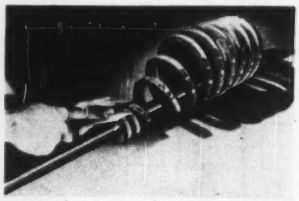
has a 1000-lb. range which can be read readily within half a division or a half pound.

The load measuring system is operated by pressure in a Bourdon tube which transmits force without itself deflecting appreciably. The force tends to displace a baffle plate over an air jet, thus building up air pressure in a pneumatic system and in a bellows which opposes the displacing force through highly accurate (iso-elastic) load-measuring springs. Extension of the springs is magnified by a rack and gear that moves the indicating pointer on the dial until the pneumatic system comes to equilibrium. Separate Bourdon tubes and air-jet-baffles are used for the two ranges.

The machine is intended primarily to determine breaking loads of specimens. However, it is possible to use with it such accessories as extensometers and automatic pacing devices for either holding constant rates of increasing load or strain. Load recording equipment may also be used with the machine. The machine is approximately 15 feet long and 30 inches wide.

Plastic Packing Manufactured with "Tape-Back" to Prevent Breakage When Installing

Crane Packing Co. of Chicago, Ill., has announced the addition of a special new feature to its "Super Seal" Plastic Packing. A securely vulcanized tape-back is now offered as an integral part of all "Super Seal" spiral packings.



This development increases packing flexibility and, for the first time, brings a plastic packing into the easy-to-handle class of ordinary braided fabric styles. Ring cutting is greatly simplified with this type of reinforcement because the spiral can be twisted down to small shaft sizes, and then cut into rings without breakage.

A primary advantage of this flexibility is the significant savings enjoyed by users of the packing. Elimination of the normal breakage which occurs in twisting-down means that none of the packing need be thrown out because of handling damage.

The problem of packing style identification has also been solved with the addition of this tape-back construction. Each Super Seal style is clearly marked in a different color for ready identification under the most adverse installation conditions.

The "John Crane" Super Seal line of packings is furnished in six different styles to cover the range of operating conditions met throughout industry. They are extremely resilient and homogeneous, and are composed of asbestos, anti-frictional metal particles, flake graphite, and special binders. They do not harden at elevated temperatures and need not be removed as wear occurs. The addition of an additional ring to the stuffing box is sufficient to maintain leak-proof service.

A special booklet offered by the manufacturer describes the entire Super Seal line and includes full service recommendations. Write Crane Packing Co., Dept. M-25, 1814 Cuyler, Chicago 13, Ill.

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Allis-Chalmers Magic-Grip Sheave Line Extended

Extension of its Magic-Grip sheave line to include A-B combination groove sheaves in sizes from 3 to 38 inches—one to six grooves—in both collar and no collar types has been announced by Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Both the collar (Style C) and non-collar (Style NC) types operate on the same principle of clamping the sheave quickly and firmly to the shaft by compressing the split tapered bushing sleeve.

The Magic-Grip non-collar bushing is a new development. It has radially adjusted setscrews and is especially designed to allow maximum bores in the smaller pitch diameters. It can be mounted and demounted as quickly as the collar bushing. The sheave itself has four radial screw holes in the hub, two at 180 degrees marked "on" and the opposite holes marked "off." Two hexagon socket cone point setscrews, operating in cone shaped recesses, tighten or release the bushing from the shaft, depending upon their position in the holes. It is available only in the smaller pitch diameters.

The Magic-Grip collar type bushing is the original Texrope drive "fast mounting unit" featuring the tapered split bushing with separate collar and axially adjusted capscrews. The sheave is clamped to the shaft by tightening three capscrews. It is released easily and quickly by loosening the capscrews and using two of them as jackscrews.

Westinghouse to Build First Four Generators for Chief Joseph Dam

Westinghouse Electric Corp. has received a $4,277,000 order from the Corps of Engineers, U. S. Army for four 64,000-kw generators to be installed at the Chief Joseph Dam Project on the Columbia River. The dam will be located approximately 50 miles below the Grand Coulee Dam and will supply power to the Pacific Northwest region over the transmission system of the Bonneville Power administration. Installation of these initial units is scheduled for the latter part of 1954 continuing into 1955.

Total cost of the project is estimated at $234,000,000. When completed, the dam will be 220 feet high and 1,484 feet long while the power house will be 2,000 feet long. The power house is designed for 27 water-wheel generators, each capable of producing 64,000 kw at 100 rpm.

• BUSINESS CHANGES

Newport News Firm Appoints Middle-West Representative

The Newport News Shipbuilding & Dry Dock Co., of Newport News, Va., has announced the appointment of the Hooper-Green Co., of Chicago and Indianapolis as its middle-west sales representative. The Hooper-Green Co. is headed by J. G. Green, with offices at 407 South Dearborn Street in Chicago. A. J. Stone is district representative of the company in Indianapolis with offices at 2313 East Michigan St. The Chicago concern will have the territory of Indiana, Illinois, Southwestern Michigan and a portion of Wisconsin and Iowa. They will represent the Newport News firm in the sale of all of the products of that company with the exception of ship work.

The Newport News company, which has long been prominent in the water power equipment field, has diversified its output since the end of the war to include production of a great many other items of industrial

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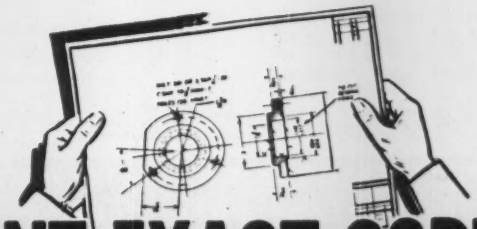

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Instrument News

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This new low-priced, miniature FRAHM® Resonant Reed Tachometer is available singly or in kits of three instruments; for hand use or permanent mounting; in ranges from 900 to 13,000 rpm, higher ranges on request. Also available with 2 rows of 21 reeds each.

The T-21 has the advantage of being small and easy to use as a pocket or tool kit instrument and yet easy to read when mounted on a machine. It has no parts to wear out, needs no maintenance, imposes no load on the machine under test, nor can it be damaged by overspeeding.

The simplicity of this resonant reed instrument in no way affects its accuracy—Frahm Tachometers are guaranteed to within 0.5% of their rated frequency of vibration.

For full details on the T-21 Frahm Tachometer, *write for Bulletin 31-35-M.*

UNIQUE INSTRUMENT INTEGRATES SPEED AND TIME
Eliminates "Human Element" of Error

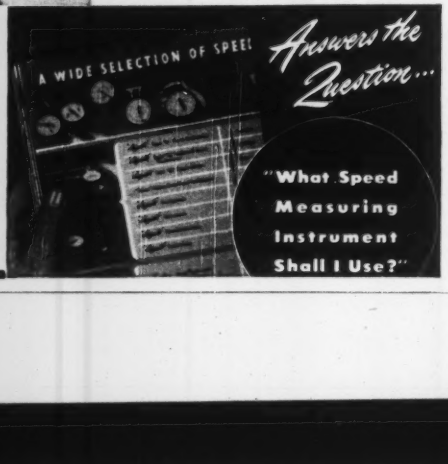
The Tachoscope is rather remarkable for what it will do in the measurement of speed. It is a speed-counter and stop watch combined in such a way as to eliminate the usual error in starting and stopping. The simple pressing of a lever starts the watch and counter at the same instant. After a suitable time—say 30 seconds to a minute or more—press the same lever to stop both mechanisms. Divide the indicated number of revolutions by the elapsed time (in minutes) and the answer is the average rpm for the time of the test. The instrument is not intended to indicate rpm or fpm directly, as do indicating hand tachometers and speed indicators.

The elimination of error at starting and stopping plus the length of time it may be operated, make the Tachoscope a high precision instrument. Many use it as a standard for other speed measuring instruments. Naturally, the longer operating time results in higher accuracy of the calculated result.

The Tachoscope can be used on many types of machines for speeds up to 20,000 rpm. The high-grade stop watch can be used independently.

SEND FOR BULLETIN 35-M
Includes Handy Selection Chart

If you don't have a copy of this bulletin which includes a handy selection chart, send for Bulletin 35-M. We will mail it to you promptly. Thousands of copies of this helpful and interesting bulletin on Speed Measuring Instruments have been requested since its publication. Did you get your copy?



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equipment. Included in this output has been rayon machinery, wool cards, petro-chemical plant equipment, thermal plant equipment, paper and pulp mill equipment and many other items of special machinery.

SKF Sets Up 11-State Western Sales Region

Philadelphia—Establishment of an 11-state sales region to expedite future requirements of western industries for ball and roller bearings is announced by SKF Industries, Inc., effective Aug. 1st.

R. R. Zisette, general sales manager, said the new region, with headquarters in San Francisco, will include territory now serviced by district offices in that city, Los Angeles and Portland and by the Denver branch office. This comprises the states of Washington, Oregon, California, Idaho, Utah, Wyoming, Montana, Colorado, Arizona, New Mexico, western Nebraska and the city of El Paso, Tex.

J. C. Bowman, district manager at San Francisco since 1936, has been appointed regional manager.

The growing industrialization of the far west, Zisette said, is reflected in increased demands for anti-friction bearings. Dollar volume of sales is triple prewar levels, he said, with aircraft, oil, steel and aluminum mills among the largest users.

Westinghouse Conducts Maintenance School

One approach to the problem of combatting maintenance costs today is to share maintenance know-how with users of your equipment. At least that is the approach Westinghouse used recently in a six weeks' course in practical methods and practices of maintenance given to 160 maintenance men.

The course gave the men attending the best and latest information available on maintenance of electrical equipment—primarily motors and controls—as well as some practical shop hints. The instructors were men who had spent an average of 20 years in maintenance work and, therefore, knew their subject from the ground up. The location was the Hillside, N. J., Manufacturing and Repair plant of Westinghouse, for here are to be found all the equipment and other facilities needed to teach proper and practical maintenance.

The course was divided into six sessions of two hours each; each session consisted of a one hour lecture and discussion followed by a one hour shop tour during which apparatus undergoing repair was examined and various demonstrations involving points covered in the lecture were performed. Each session was given twice to keep classes to a more workable size, as there were 160 maintenance men from 96 different nearby plants attending the school.

Each of the six sessions covered a different topic. The first session covered preventive maintenance; the second, ac motors; the third, dc motors; the fourth, ac and dc controls; and the fifth, transformers and frac-

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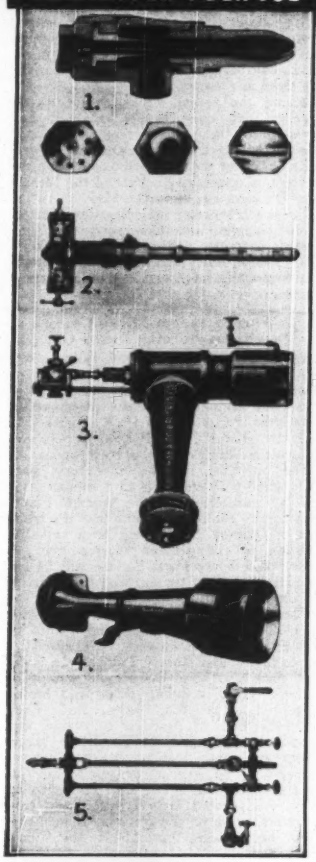

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5. (Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, tars, pitches, etc., in combination with fuel oil. Send for Bulletin No. 21.

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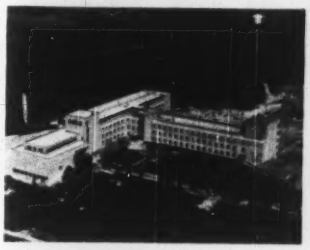
tional horsepower motors. The final session consisted of a lecture on plant safety, followed by a banquet in the plant cafeteria. The banquet was highlighted by the awarding of certificates by Mr. Swan Weber, Eastern District Manager, and Mr. H. R. Larson, Eastern District M & R Manager for Westinghouse.

The General Electric Research Laboratory

The new quarters of the nation's first industrial research laboratory, the General Electric Research Laboratory, are nearing completion near Schenectady and soon will be fully occupied, it was announced recently by Dr. C. G. Suits, G-E vice president and director of research.



A revolutionary type of laboratory structure, the virtually completed plant is located in nearby Niskayuna Township on what was once a farm estate known as "The Knolls," on a high bluff overlooking the Mohawk River. Construction began in 1946.

Dr. Suits said that the remaining sections of the new facilities are being rushed to completion, and that most laboratory divisions still located at the main G-E Works in downtown Schenectady have begun to move. The entire laboratory will be completely occupied by late August, he said.

Exclusive of minor service buildings, the laboratory plant totals 5 buildings with a usable area of about 185,000 square feet. This includes the main five-story building with 160,000 square feet of usable space, the Radiation Laboratory where the 300,000,000-volt synchrotron and other atom-smashers will be installed, a low-temperature laboratory where helium is liquefied for studying effects at temperatures near absolute zero (460°F below zero), a chemical pilot plant to try out chemical processes on a larger scale than possible in laboratory rooms, and others. There are shops for machine work, as well as for woodworking, welding, glass blowing, and electronics.

Since the problems and methods of research work are constantly changing, and a structure meeting today's needs may well be inadequate for the future, it was decided that most of the new laboratory would provide "universal space." Dr. Suits explained that this concept of building design permits the installation of any research facilities as desired.

The basic keys to this flexibility of building layout are the ready availability of the many services required for research work and the use of movable steel partitions. A series of vertical shafts at 12-foot intervals on both sides of the halls of the five-story main building provide such services as direct and alternating current electricity of various voltages, oxygen, hydrogen, nitrogen, illuminating gas, compressed air, vacuum, steam, distilled water, city water, and a drain. These readily-available services and the use of movable partitions permit laboratory rooms of

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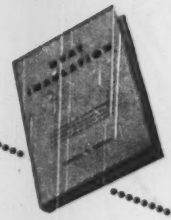

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129 Useful Graphs and Charts.

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BULLETIN 5008

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any size, ranging from six feet in width up to the length of the building.

Many safety features have been incorporated in the building. A fire alarm system gives instant notice of a fast rise of temperature in any part of the plant. Each laboratory room has two exits.

During the recent weeks the Research Library, with over 16,000 volumes, has moved into the new section, he added. Transfer of the Chemistry Division, which was the largest group remaining in the old quarters, is under way. Part of the Metallurgy Division was moved in May.

The new laboratory buildings were erected by the George Fuller Construction Co., as general contractor, following plans by Voorhees, Walker, Foley and Smith, an architectural firm which has specialized in laboratory construction.

Warren Steam Pump Co. Purchases Quimby Pump Co.

Announcement is made by William W. Shuttleworth, Executive Vice President of Warren Steam Pump Co., Inc., that negotiations have been concluded for the purchase of Quimby Pump Div. of H. K. Porter Co., Inc., Pittsburgh, Pa. Formal papers are being processed by counsel of both parties.

The purchase includes inventory, patterns, good will, etc., and all manufacturing will be transferred to the Warren Plant. It is felt by the management that the addition of Quimby Pumps will be a valuable addition to the present Warren line. A Repair and Spare Parts Service will be set up to take care of present and future users of Quimby Pumps.

The original Quimby Co. was established in 1893 and formerly operated plants in Newark and New Brunswick, N. J., specializing in Screw and Rotary Pumps. In addition they also built Centrifugal pumps of various types, including single and multistage, close coupled, sump, etc. They were the first in America to design and produce a balanced quadruplicate screw pump and applied it to the handling of molasses. The salient design feature of separate pumping screws and timed driving gears inaugurated then is the basic construction to-day. Progressive refinements have been made throughout the years, widening the scope of applications to include the handling of any nonabrasive liquid at moderate and high pressures.

Key men formerly with Quimby have been employed by Warren to supervise the production and application of Quimby Screw and Rotary Pumps, both items being new in the Warren line.

The Warren Steam Pump Co., Inc., was established in 1897 and Steam Pumps were the original product. In 1924 the Company went into the production of a complete line of Centrifugal Pumps, and as distribution became nation-wide all original buildings and equipment were replaced by those of most modern construction and advantages.

• LATEST CATALOGS

New Brochure Covers All Sam Tour Services

With technology, engineering and research so prominent in present-day commerce, a new brochure has been prepared emphasizing the necessity for these technical services. "All Under One Roof" is illustrated with action photographs of jobs both in the laboratory and field. This brochure portrays the work of scientists, engineers, consultants, and

• Keep Informed

laboratories at Sam Tour & Co., Inc., 44 Trinity Place, New York 6, N. Y.

It explains the scope of the services available from this independent organization and touches on such subjects as research, process development, product development, production methods, evaluations, expert testimony, investigations, non-destructive testing and inspecting, laboratory testing and analysis. Copies of "All Under One Roof" are available from Sam Tour & Co., Inc., 44 Trinity Place, New York 6, N. Y.

Twin Disc Announces Hydraulic Coupling Bulletin

A new bulletin on their complete line of hydraulic Couplings has been announced by the Twin Disc Clutch Co., Racine, Wisc. Application recommendations are given for all sizes of Twin Disc Hydraulic Couplings from 7.4" to 27", for engines and motors in the complete range from ¾ to 700 hp. For each model a schematic drawing shows how the coupling is mounted between prime mover and driven equipment. Copies of the new bulletin, #144-B, may be obtained on request from Twin Disc.

Farrel-Birmingham Publishes Roll Grinder Bulletin, Offers Literature on Complete Line

Farrel-Birmingham has published a new bulletin entitled "Farrel Two-Wheel, Swing-Rest Roll Grinders." The 16-page booklet fully describes and illustrates what the company advertises as the most accurate mechanism yet devised for grinding calender rolls and includes a thorough explanation of the swing-rest principle which, it is claimed, contributes importantly to the extreme accuracy of the roll grinder's performance.

This bulletin, No. 118, is one of a set of five which describe Farrel products manufactured for the paper industry. The four others are designated as follows: Bulletin No. 112—"Farrel Indicating Calipers," Bulletin No. 114—"A Practical Guide to Care of Calenders and Calender Rolls," Bulletin No. 116—"Farrel Rolls for Paper Mills," and Bulletin No. 117—"Farrel Paper-Machine and Board Calenders."

Any or all of these bulletins are available to those interested in paper-making equipment. Copies may be obtained by writing Farrel-Birmingham Co., Inc., Ansonia, Conn.

Friction Clutches

Morse Chain Co.—Small diameter, over-center, friction clutches adaptable to a wide variety of applications are described in 12-page catalog, SDOC. These small clutches use the same over-center principle as do high-torque, heavy duty tractor and hoist clutches. Four related types are offered to meet various applications by utilizing different standard driving cups.

Handbook Available on Methods of Working Seamless Tubes and Pipe of Intermediate B&W Croloys

The latest edition of a reference handbook on Methods of Working Seamless Tubes and Pipe of the Intermediate B&W Croloys, ferritic air-hardening alloys containing ½ to 9% chromium, is offered by The Babcock & Wilcox Tube Co. It incorporates new data accumulated since 1946, the publication date of the previous issue.

The former bulletin has been redesigned as a pocket size book with durable, flexible leatherette covers. Arranged for easy reading, it is briefly but carefully indexed and illustrated with photographs, diagrams and reference tables. Intended to help simplify fabrication of the intermediate B&W Croloy Tubing steels, it presents the latest

Continued on Page 68

Never an Uncertainty in SURFACE ROUGHNESS RATING

At Holley Carburetor Co. . . . . the Profilometer Type Q Amplimeter, Type V Mototrace and AW Tracer in use.

where the

PROFILOMETER is Used

Throughout industry, the term "Profilometer reading" has become a generally accepted designation of surface finish—and for good reason. By no other method nor with any other instrument can measurements of surface roughness be made as rapidly and accurately. Meter readings taken on a given path of trace agree, no matter who uses the Profilometer . . . and these are readings in microinches r.m.s., the standard measurement of roughness height.

In addition, the Profilometer provides the *fastest, simplest* and *most versatile* means of obtaining dependable roughness ratings for all surfaces from a fraction of a microinch to 1000 microinches r.m.s. roughness.

To be *sure* of the surface roughness measurements being made in your production and inspection departments, you need "Profilometer readings." To get them, you need the Profilometer.

THESE FREE BULLETINS (L-6 and L-11) give full details of the Profilometer and its many applications. Write for it today.

Profilometer is a registered trade name.

PRC

PHYSICISTS RESEARCH COMPANY

Instrument Manufacturers

ANN ARBOR 6 • MICHIGAN

practical data or instructions for proper handling of these alloys to obtain maximum benefit from their use. Information on the following is included: composition, general characteristics, annealing practice, methods of hot and cold working, welding, condensed technical data, and general reference tables.

The welding section has been completely rewritten and brought up-to-date. The information on intermediate Croloys is broadened to include data on Croloy ½ and Croloy 1, two relatively new but popular B&W Alloy Tubing steels for high-temperature service. The new handbook, Technical Bulletin 9B, may be obtained on request from The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

SK Steam Jet Syphons

A full line of SK Steam Jet Syphons which operate on the jet principle utilizing the energy of steam under pressure to pump, heat, mix liquids and handle solids is described and illustrated in new Bulletin 2-A recently issued by Schutte & Koerting Co., Philadelphia, Pa.

The 24-page catalog is divided into three sections.

Section 1 details the design, application, construction and operation of the various types of syphons available. Text material is supplemented by photographs and color drawings showing the operation and working parts of the syphons. For complete information, sizes, dimensions, prices and capacities of each type are included in tabular form.

Special purpose and corrosion resistant syphons are covered in Section 2 of the catalog. Each special purpose syphon is described and illustrated.

Typical applications of steam jet syphons in the pumping, heating and mixing of liquids and the handling of solids are included in Section 3, of special interest to plant and process engineers. Detailed color drawings accompany the descriptive material.

For copies of this catalog, write to Dept. JC, Schutte & Koerting Co., 1166 Thompson Street, Philadelphia 22, Pa.

New Link-Belt P.I.V. Drive Book

Link-Belt P.I.V. Variable Speed Drives, available in 8 sizes and 16 types, in horse powers of ½ to 25, with manual and automatic controls, are illustrated, listed and described in a new 88-page Book No. 2274 published by Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.

A special feature of the new book is the convenience with which a P.I.V. of the right specifications for a specific service may now be selected directly from its 36 pages of "Preselected Drives." Diagrams of automatic speed control applications, and pages of photographs showing a great variety of P.I.V. installations throughout the industries, are other features. A copy of new Link-Belt Book No. 2274 will be forwarded to any interested reader upon request.

New Booklet Describes Reproduction Methods

A new, 16-page booklet, "Modern Drawing and Document Reproduction," describes photographic materials and methods for improving legibility of reproduced engineering drawings and business documents.

Published by the Eastman Kodak Co., the booklet provides information on reproduction of tracings, blueprints, and opaque drawings on paper, film, and cloth. Specialized recommendations describe suggested procedures for restoring old drawings and eliminating hand tracing.

Additional information is provided on reproducing business forms, correspondence, and card records. Microfile equipment is briefly described, together with projection materials for making prints from microfilm negatives and for making change-of-scale copies.

The booklet is obtainable without charge from the Industrial Photographic Div., Eastman Kodak Co., Rochester 4, N. Y.

Boiler Feedwater Control

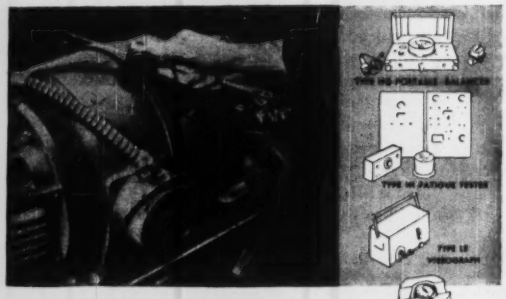
A new bulletin describing and fully illustrating the one, two and three element boiler feedwater control system has recently been released by the Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill. A comparison of the three systems and the advantages of each are featured in this eight-page brochure. Write for Republic Bulletin No. S-52.

Worthington Bulletin on Mixflo Pumps

A new bulletin W-317-B16 on Worthington Pump & Machinery Corp. "Mixflo" pumps with two-vane closed impellers is announced. These pumps in types MC, MCC, MCF, MCV, MCZ, sizes 10, 12 and 16, 60-cycle, are used for irrigation, drainage, sewage disposal, condenser circulating, and low-speed water supply.

The 16-page booklet includes line drawings, general data, performance curves, fittings of standard pumps, shafting charts, sizes of motor stands required for various motor sizes and dimensions.

YOU CAN BE SURE.. IF IT'S Westinghouse



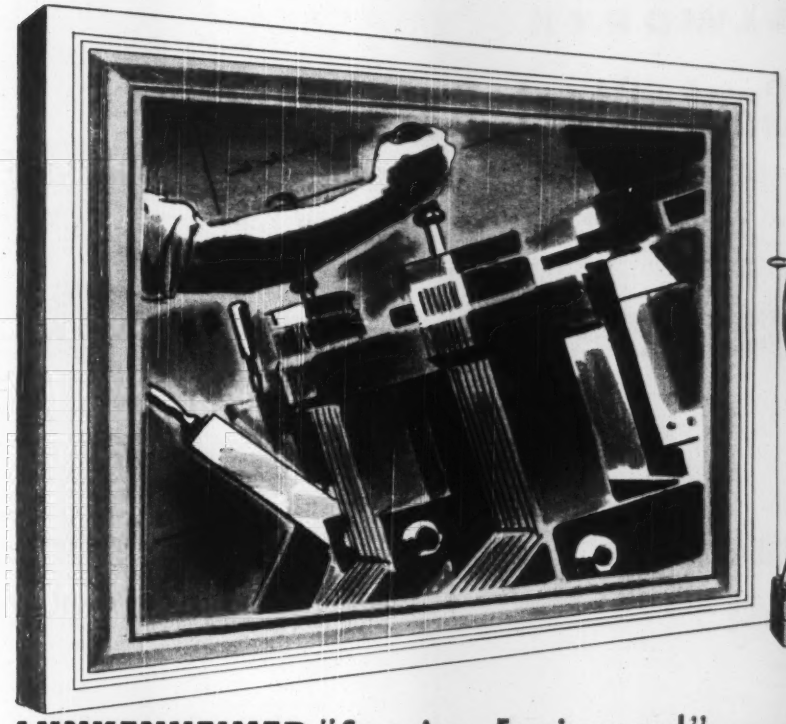
Measure Vibration *in a hurry!*

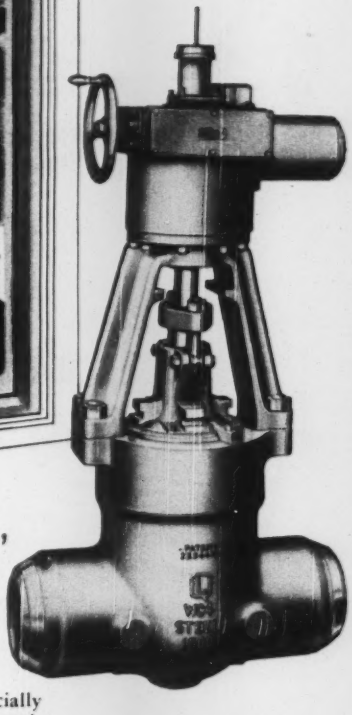
TYPE MH VIBROMETER

Track costly vibrations with inexpensive tools. The Westinghouse Types MH and JC-1 Portable Vibrometers are instruments that supply immediate readings of amplitude and frequency respectively. They provide data essential for elimination of harmful vibration. For complete information on this and other vibration testing equipment, write Westinghouse Electric Corporation, Department E-3, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-02211

Westinghouse VIBROMETERS

Here's a Tip for Stalled Transmission Designers
Thousands of design engineers have discovered that ROCKFORD CLUTCHES fit compactly into product designs because they deliver maximum torque with minimum bulk and weight. The extensive ROCKFORD line offers you the widest selection of clutch types, sizes and capacities. An experienced ROCKFORD CLUTCH engineer will be glad to make recommendations that will help solve your transmission design problems by meeting your clutch needs exactly. Let him suggest how you can improve that NEW design.
ROCKFORD
Power Take-off
CLUTCHES
BW
ROCKFORD CLUTCH DIVISION
BORG-WARNER
1307 Eighteenth Street, Rockford, Illinois





LUNKENHEIMER "Service-Engineered" Steel Valves Will Meet YOUR SPECIFIC APPLICATION PROBLEMS

MAINTENANCE costs need specialized attention, these days—especially in the power field, where steel valves are vitally important. There's no cure-all for your valve maintenance problem. It has to be tackled an installation at a time — service by service — and that's where Lunkenheimer engineering comes in.

Lunkenheimer breech-lock valves are your insurance against excessive valve maintenance. Gaskets, rings, flanges, and bolting, all of which tend to induce leakage because of their instability at high pressures and temperatures, have been eliminated. Bodies and bonnets are locked securely together by intermeshing lugs that carry the full internal pressure. Maintenance of the joint is never required, and pressure tightness is unaffected by high pressures, high temperatures, sudden quenches, or creep. It's simplicity itself — an exclusive, patented design, developed by Lunkenheimer to eliminate any possibility of bonnet-joint leakage. Call in the Lunkenheimer representative in your area. He'll be glad to put at your command all the generations of successful experience behind Lunkenheimer's complete selection of "service-engineered" steel valves. For his address, write The Lunkenheimer Co., P. O. Box 360E, Cincinnati 14, Ohio.

STEEL • • • IRON • • • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

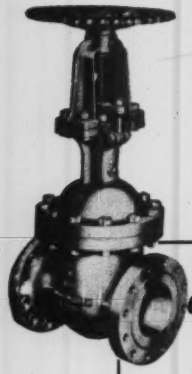
L-950 13C

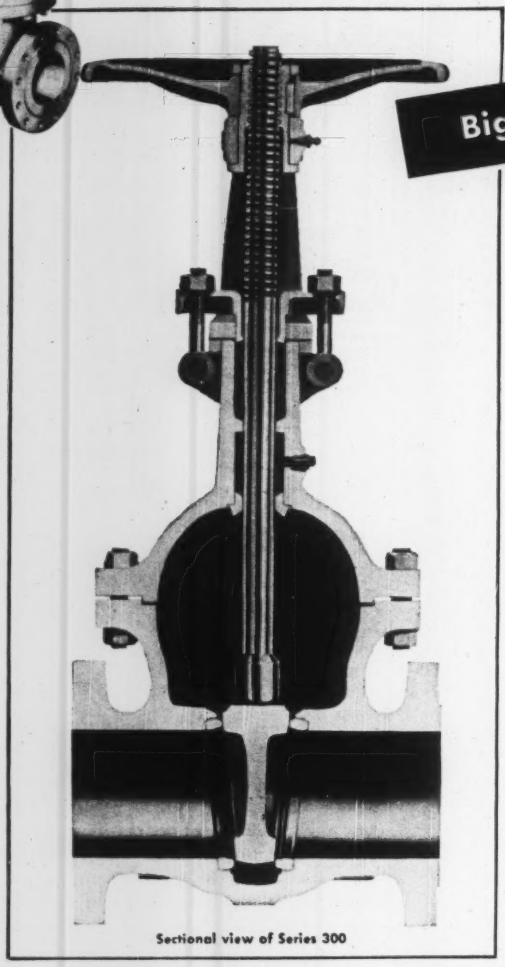
WALWORTH

Cast Steel Gate Valves

Series 150 and 300

Wedge Gate — Outside Screw and Yoke





Sectional view of Series 300

Big 8-Point Superiority!

Gland clearances are such that stem cannot be scored if gland should be tightened unevenly.

Deep Stuffing Boxes in all sizes (2″ to 24″) insure tightness and maximum packing life – costly leaks are eliminated.

Bonnets and Bodies are engineered to withstand pressure and minimize distortion – they're tough, durable, dependable.

Heavy Steel Walls provide extra strength and longer life.

Integral Body Guide Rib Faces are machined to insure accurate disc seating.

Seat Rings are bottom seated – not flange type. No recess exists at back of ring – hence no turbulence, erosion, or pressure drop.

Streamlined Ports allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

Valves regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.

For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

WALWORTH

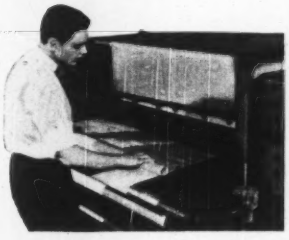
valves and fittings

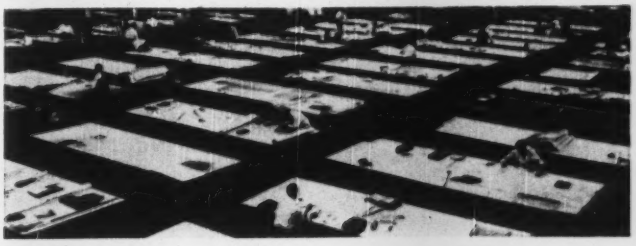
60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

A $75,000 per year saving in the making . . .

Streaming off this continuous processing machine at the Ford Motor Company . . . are Kodagraph Autopositive prints—positive photographic intermediates of original drawings. *The answer to a $75,000 per year redrafting headache!*



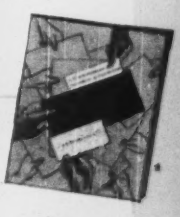


Before . . . Ford's valuable original drawings had a short life . . . had to do double duty in the drafting room and in heavy print production. In the latter operation, they were exposed to machine wear and tear, constant handling. Soon they lost their detail . . . produced illegible blueprints . . . which meant that new drawings had to be ordered from the drafting room.

Now . . . Ford's originals are filed away in the drafting room after Kodagraph Autopositive intermediates are made—available for reference and revisions only! All blueprints are produced from the "Autopositives," whose photographic black lines will not smudge or lose opacity . . . assuring highly legible prints even after hundreds of "run throughs." As a result of this simple change in routine, *redrafting costs are reduced by an estimated $75,000 per year . . . while the output of creative drafting is increased.* And print production is simplified, too . . . for Kodagraph Autopositives are not only longer-lasting . . . but can be printed at uniform, practical machine speeds.

Kodagraph Autopositive Paper

"The Big New Plus" in engineering drawing reproduction



You, too, can cut your drafting costs, get improved legibility, and simplify print production . . . by reproducing your drawings on this new, low-cost photographic intermediate paper.

You can turn out "Autopositives" quickly, economically . . . with your present print-making equipment and standard photographic processing. Or else you can order them from your local blueprinter. *It will pay you to get all the facts soon!*

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

16

GENTLEMEN: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Paper.

NAME_____ **POSITION**_____
(please print)

COMPANY_____ **STREET**_____

CITY_____ **STATE**_____

Kodak
TRADE-MARK

Deliver twice the volume of the Arkansas River

with One ECONOMY PUMP

200,000 gallons a minute can be delivered by one Economy Axial Flow pump!

That's double the mean discharge of the Arkansas River at La Junta, Colo.

For any high capacity, low head application, these pumps are ideal. Operating at high speeds they are light in weight and low in cost.

Installation is simple and inexpensive. No dry well is needed. Just drop pump into channel or wet well and connect Dresser coupling at discharge. It is not even necessary to accurately align piping.

Three general types are available: Light Duty for irrigation uses; Standard Duty for flood control; and Heavy Duty types for continuous service, such as condenser circulation. A special Heavy Duty "Pullout" type is built to allow removal of shaft and rotor without disturbing piping.

Economy Axial Flow Pumps are made with either oil or grease lubricated bearings, water lubricated rubber bearings and open or enclosed shafts. Capacities range from 1,000 G.P.M. to 200,000 G.P.M. at heads up to 75 ft.

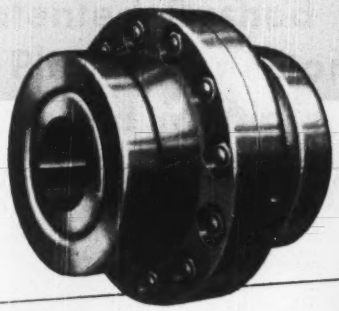
For complete details, write Dept. CM-9 for Bulletin No. G-845.

Centrifugal, Axial and Mixed Flow Pumps for all applications.

Economy Pumps Inc.

DIVISION OF HAMILTON-THOMAS CORP. HAMILTON, OHIO

GOT A COUPLING PROBLEM



Here's how KOPPERS Engineers *Eliminate Guesswork* when you buy couplings!

These FAST'S COUPLING *Services save you money!*

UNSURPASSED ENGINEERING . . . Koppers' engineers are acknowledged the best in the industry. Their practical knowledge, backed with 30 years' coupling experience, is at your service!

IMMEDIATE DELIVERY . . . All standard types and sizes are available for immediate delivery from "on hand" stocks. In case of emergency, just wire factory for special rush delivery!

LOWEST COST PER YEAR . . . Fast's Couplings will outlast equipment they connect if properly maintained. Their cost may be spread out over 25 years or more, offering you lowest coupling cost per year!

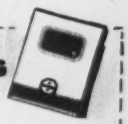
No matter what size couplings you need—whatever the service—*see Koppers first!* Because only Koppers offers you Fast's Couplings, *proved* the best insurance for coupling problems you can buy! For 30 years, Fast's have been industry's standard for *low-cost, trouble-free* coupling operation.

When you specify Fast's you get the benefit of Koppers Engineering service, acknowledged finest available. Koppers engineers, backed with *30 years* of Fast's Coupling experience, study your problem. Then show you *which* Fast's Coupling you need (and more important) *why you need it!*

Take advantage of Koppers long-term coupling experience. Buy Fast's Couplings and get Koppers *valuable* Engineering Service—a service you cannot buy, but which Koppers offers without obligation. The Fast's Catalog contains full details. Mail coupon for your copy today!

KOPPERS **FAST'S** THE ORIGINAL GEAR-TYPE *Couplings*

SEND FOR FREE CATALOG



KOPPERS CO., INC., *Fast's Coupling Dept.*,
259 Scott St., Baltimore 3, Md.

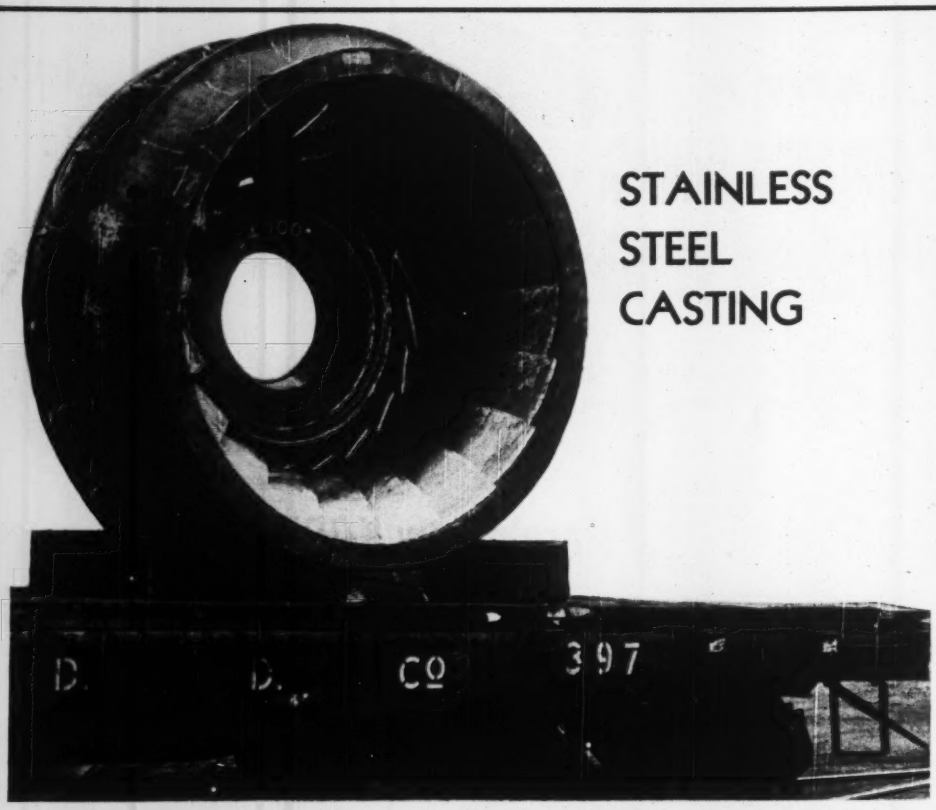
Please send me a copy of Fast's Catalog relative to.....
.....(type of industry).

Name.....

Company.....

Address.....

City.....Zone.....State.....



ELEVEN ACRES OF FOUNDRY FACILITIES

The above 24,000 pound 18% chromium and 8% nickel stainless steel hydraulic turbine runner casting was recently produced in the Newport News foundries for the Hoover Power Plant in Nevada.

Eleven acres of foundry facilities including modern sand handling, mold making and melting equipment, are available for producing castings. In addition to metallurgical laboratory facilities for physical and chemical analysis, Newport News is equipped with Gamma-Ray, Radiograph and Magnaflux equipment to assure thorough inspection of foundry products.

Your inquiries for stainless steel, iron, steel and brass castings will receive prompt attention.

NEWPORT NEWS

Shipbuilding and Drydock Company

Newport News, Virginia

ANOTHER ROLLER CHAIN ENGINEERING ADVANCE FOR SEVERE SERVICE

The file-hard bushings resist wear, add life.

Patented Bushed Center Plate Connector for Diamond Multiple Strand Roller Chain

U. S. Patent 2,466,639 April 5, 1949

● Diamond Chain pioneered the use of press fit center plate construction for Multiple Strand Roller Chain for severe service applications some years ago.

Now Diamond Chain offers a Connector for these chains which provides durability closely matching that of chain with press fit center plate construction and ease of assembly and disassembly equal to that of slip fit center plate design.

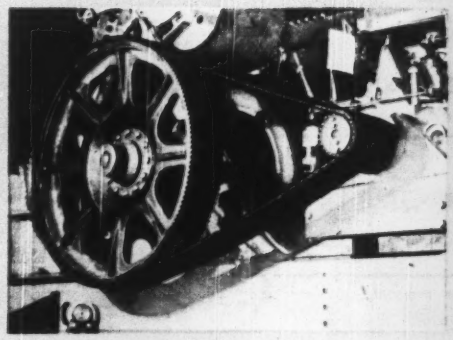
File hard bushings are pressed into pitch holes of pairs of center plates making one unit; the bushings then being ground for hole and pitch accuracy. Wear is greatly reduced, thus assuring full support of the pins at the connector across all strands throughout the long service life of the chain.

If you have a problem where the duty or service is heavy, you can benefit through this Diamond engineering development. Our staff of experienced engineers can help you with practical recommendations.

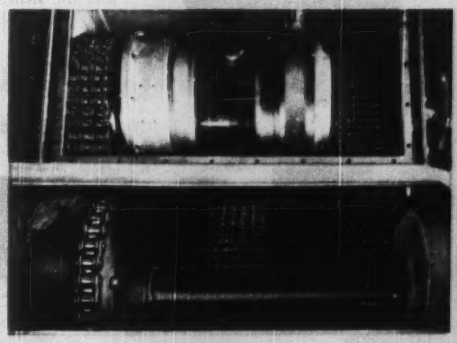
DIAMOND CHAIN COMPANY, Inc.
Dept. 413, 402 Kentucky Ave., Indianapolis 7, Ind.
Offices and Distributors in All Principal Cities
Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

This shows the pairs of bushed center plates through which connecting link pins pass.

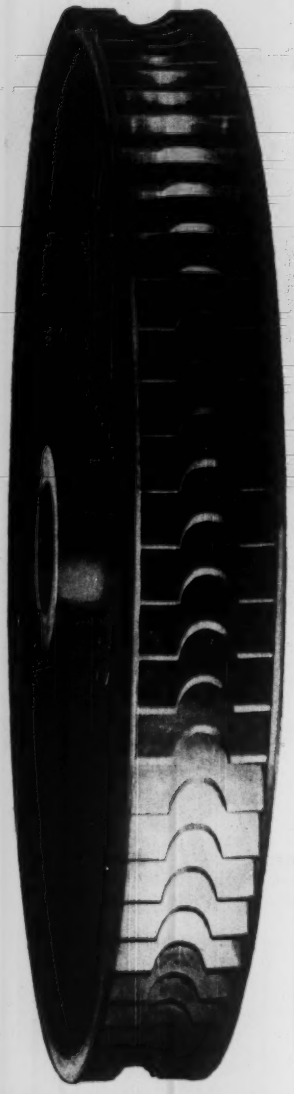
DIAMOND **ROLLER CHAINS**

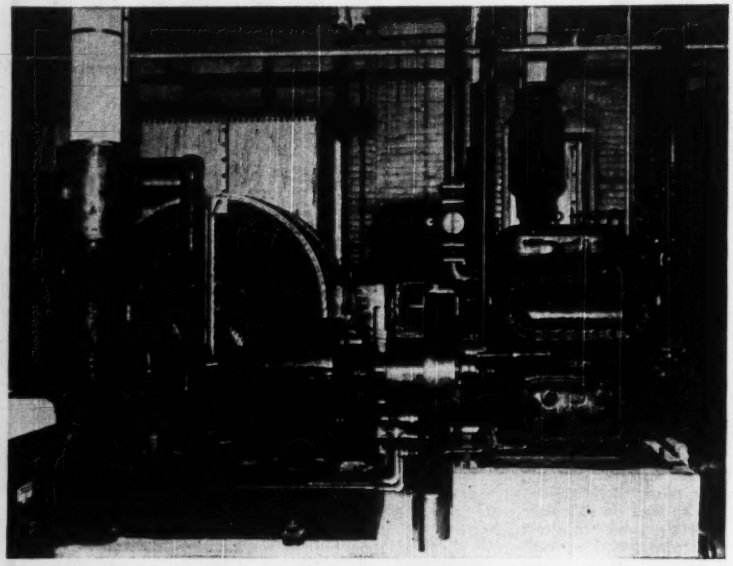


For Heavy Duty jobs, multiple-strand Diamond Roller Chain with new Connecting Links add extra life and reduce costs.



the Terry Turbine





Refrigeration Compressor Driven By Terry Turbine

AT HAMPDEN BREWERY

This 150 hp Terry Turbine — at the Willimansett, Mass. plant of the Hampden Brewing Co. — operates at 3800 rpm with a gear reducing it to 720 rpm. It is coupled to a 6 cylinder reciprocating compressor.

The installation is running on steam conditions of 120 psi — 0° superheat, and the steam to the turbine is automatically throttled to maintain a constant 30 psi back pressure for process and heating. The installation was developed by Fred Ophuls & Associates Consulting Engineers.

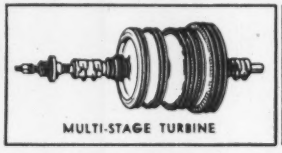
Get more information on the wide range line of Terry Turbines from your local District Representative. There's no obligation for a complete discussion of your specific requirements. Also send for Bulletin S-143 that gives full details.

THE TERRY STEAM TURBINE CO.

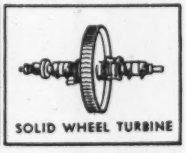
TERRY SQUARE, HARTFORD 1, CONN.

TT-1184

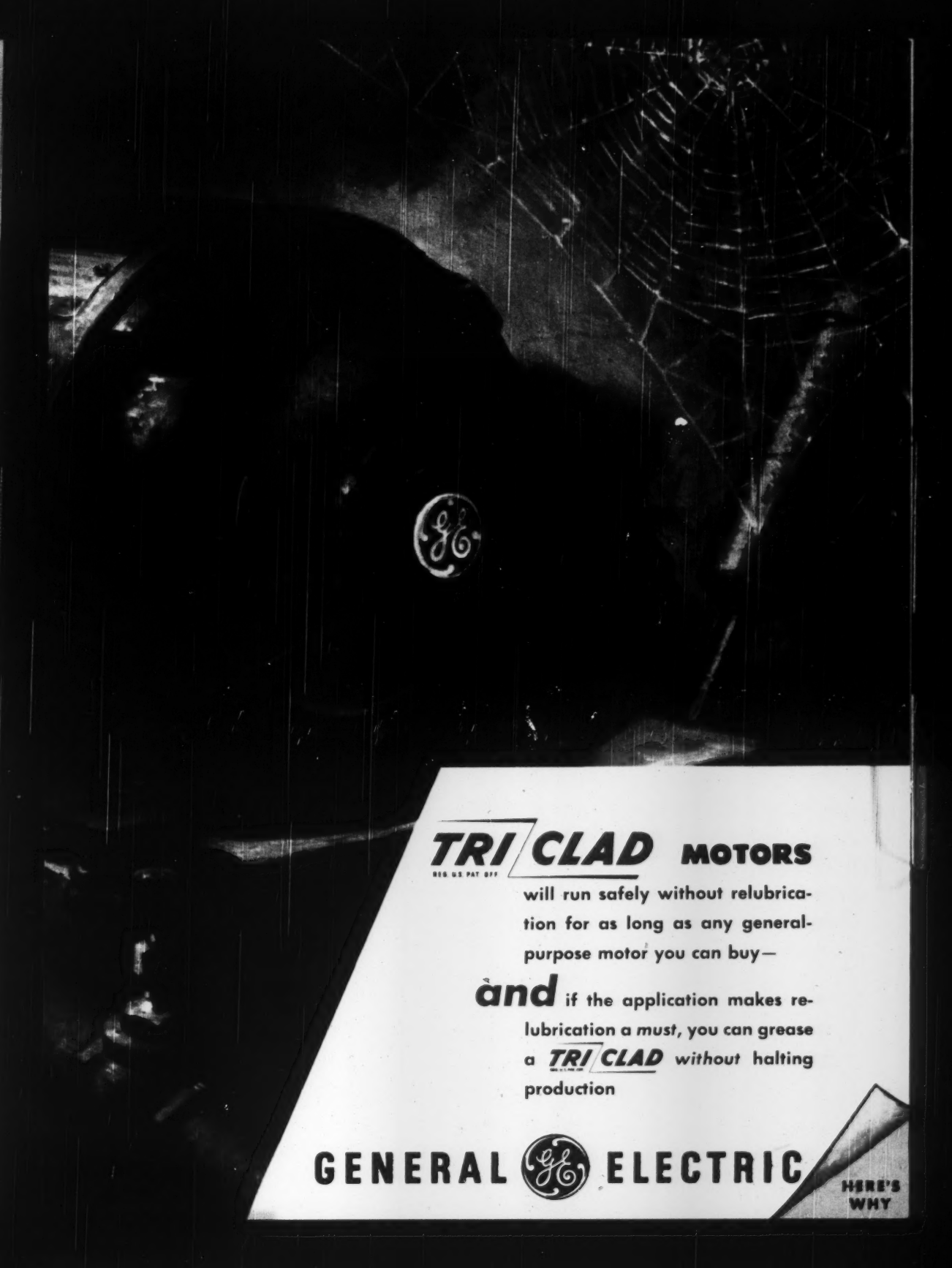
Terry



MULTI-STAGE TURBINE



SOLID WHEEL TURBINE


TRI CLAD MOTORS
REG. U.S. PAT. OFF.
will run safely without relubrication for as long as any general-purpose motor you can buy—
and if the application makes relubrication a must, you can grease a TRI CLAD without halting production
GENERAL ELECTRIC
HERE'S WHY

TRI CLAD MOTORS will run safely without relubrication for as long as any general-purpose motor you can buy—

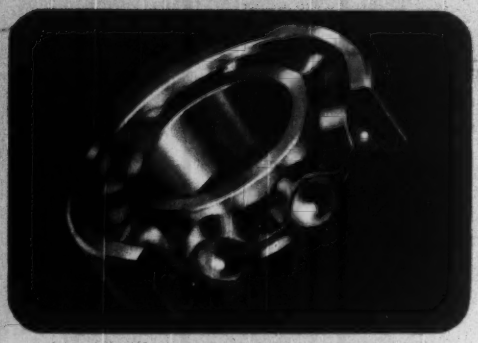
Tri-Clad extra lubrication "protection" can save you money because:

1. Tri-Clad's oversize grease reservoir and the heaviest standard-service bearings mean you do not have to bother with greasing between motor check-ups.

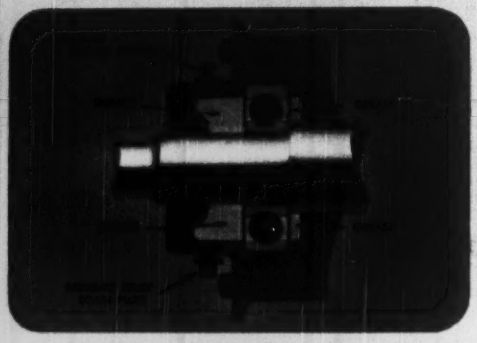
2. When relubrication is needed on those tough applications, you can grease a Tri-Clad without interrupting production-line operations.

Tri-Clads are grease-gun easy to lubricate *on the job*. Moreover, a Tri-Clad motor will run safely where an ordinary motor would fail. Chances are you'll be spared the cost of a "special" motor.

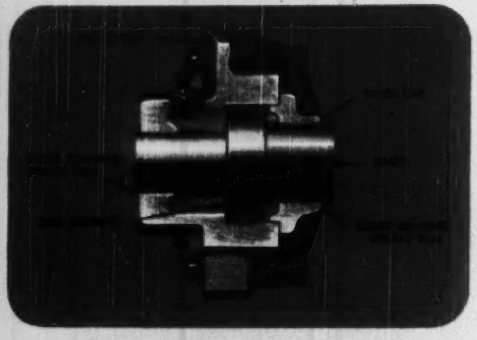
YOU BE THE JUDGE! The best way to prove to yourself that Tri-Clad gives you the most for your motor dollar is to contact your local G-E office. Tri-Clad stocks are complete. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



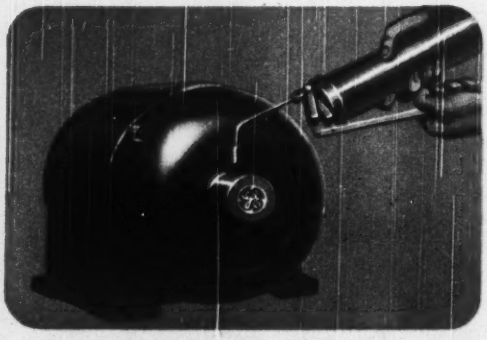
1 **EXTRA BEARING PROTECTION** — Tri-Clad gives you extra bearing protection because heaviest standard-service bearings are carefully selected to withstand severe loads for long periods.



2 **EXTRA GREASE** — Four times the ordinary amount of grease is packed into the large Tri-Clad grease reservoir. Since bearing life depends on grease, this means that Tri-Clad motors will run safely for years — for as long as any general-purpose motor you can buy.

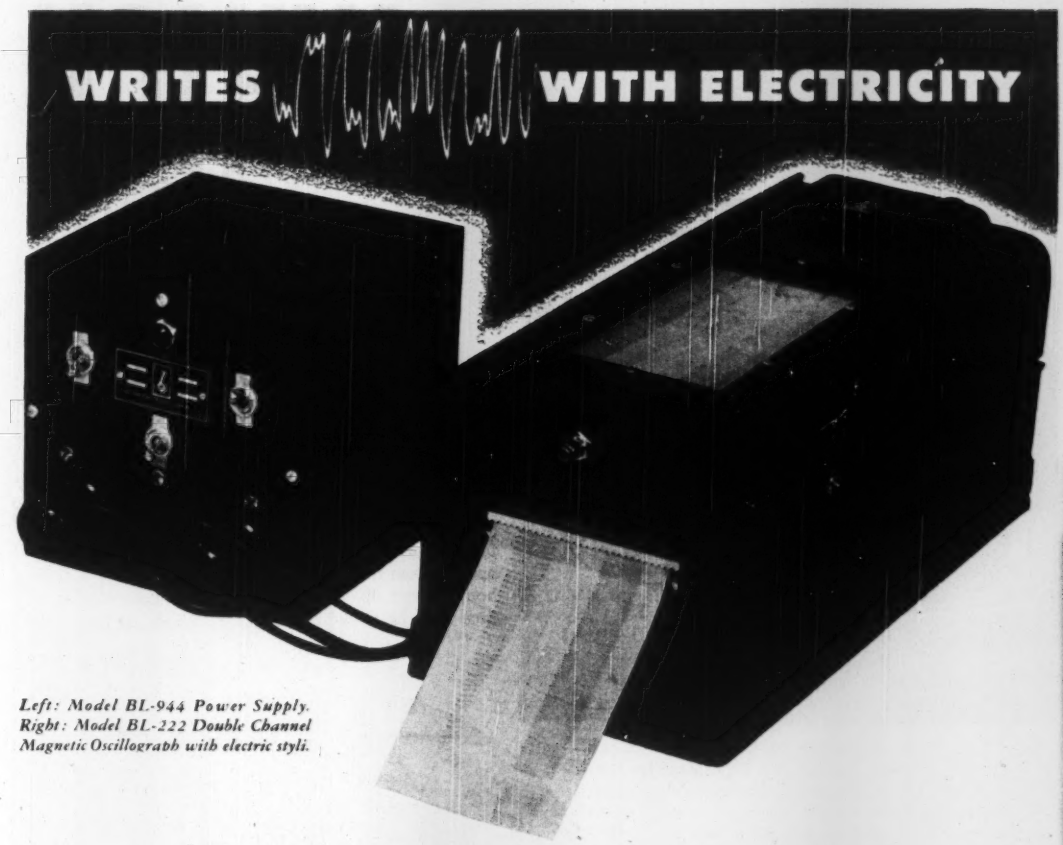


3 **SEALED-IN BEARINGS** — Bearings and grease are completely sealed in a cast housing with long running seals for extra protection from dirt, dust, and lubricant leakage.



4 **PRESSURE-RELIEF GREASING** — An efficient system of pressure-relief lubrication (with standard fittings) enables a Tri-Clad motor to be quickly and easily greased on the job when and if it's needed.

GENERAL ELECTRIC



Left: Model BL-944 Power Supply.
Right: Model BL-222 Double Channel Magnetic Oscillograph with electric styli.

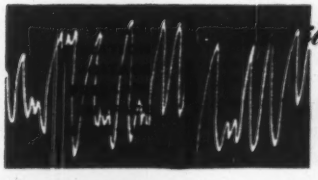
New BRUSH Combination Oscillograph has interchangeable electric stylus and inking pen

● To improve the recording of variable phenomena under extreme conditions such as high or low room temperatures, The Brush Development Company introduces the Model BL-221 Single Channel and Model BL-222 Double Channel Combination Magnetic Oscillographs for use with either electric stylus or inking pen. These combination units are furnished with Model BL-944 Electric Stylus Power Supply, electric stylus, inking pen, inkwell and both standard and electric-recording chart paper.

The Model BL-944 Power Supply, shown above on the left, has a switch on the front panel to increase stylus voltage for recording high frequency phenomena.

Write for details on these new Brush instruments... or for information on conversion of standard direct-inking oscillographs to combination types.

THE *Brush* DEVELOPMENT COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A.
Canadian Representatives: A. C. Wickman (Canada) Ltd., P. O. Box 9 Station N, Toronto 14, Ontario

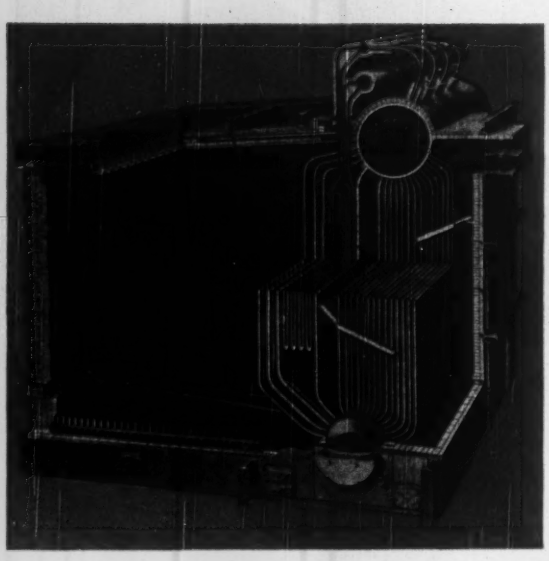


t in writing with a

BRUSH RECORDING ANALYZER

STRAIN ANALYZERS • SURFACE ANALYZERS • CONTOUR ANALYZERS • UNIVERSAL ANALYZERS • UNIFORMITY ANALYZERS

WHICH fits



Type VU-50

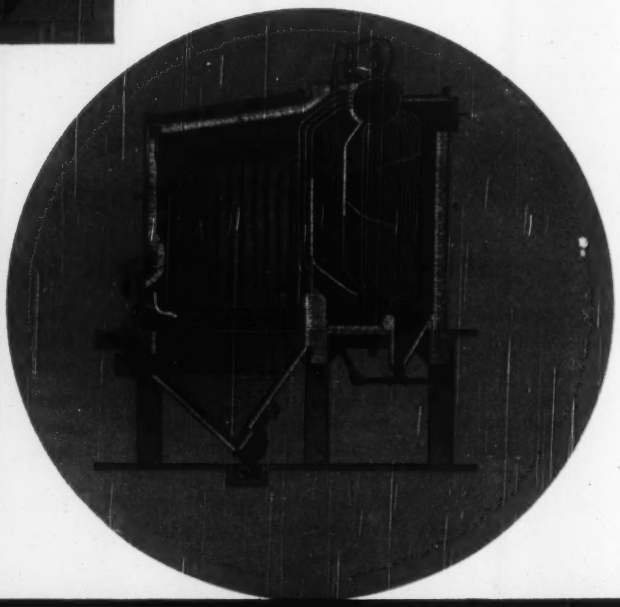
(for the higher capacity range)

This unit, the original VU design, may be fired by pulverized coal, oil or gas, or any combination of these fuels. Available for capacities up to 300,000, or more, lb of steam per hr, pressures up to 1000 psi and steam temperatures up to 900 F, or higher. Furnace bottom may be as shown or may be of hopper type. Economizer or air heater surface may be added.

Type VU-30

(for the middle capacity range)

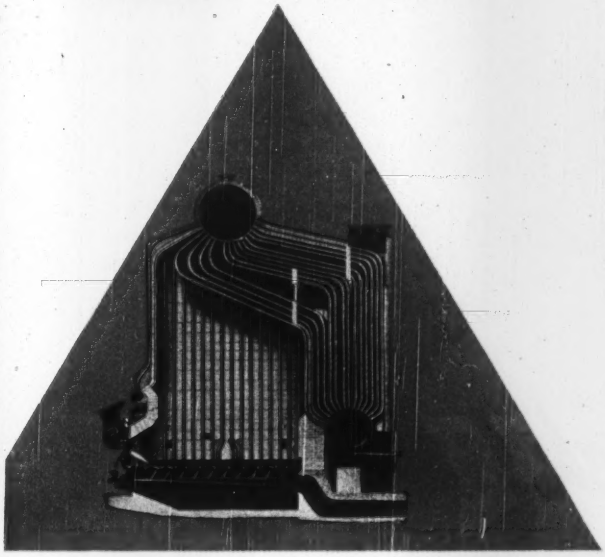
In this VU design, shown equipped with a C-E Spreader Stoker, the furnace proportions and arrangement of water wall surfaces may be adapted for firing by any type of mechanical stoker. Design is also adaptable for firing by oil or gas. Economizer or air heater surface may be added. Approximate capacity range 25,000 to 100,000, or more, lb per hr.



COMBUSTION ENGINEERING

ALL TYPES OF BOILERS—FURNACES—PULVERIZED FUEL SYSTEMS AND STOKERS—ALSO SUPERHEATERS—ECONOMIZERS AND AIR HEATERS

Vertical-Unit Boiler <u>your</u> special needs ?



Type VU-10

(for the lower capacity range)

This member of the VU family is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 10,000 to 60,000 lb per hr. Firing may be by spreader, underfeed or chain grate stokers, or by oil or gas burners. Superheater, economizer or air heater surface may be added if desired.

No matter what your combination of operating conditions, one of these three units can meet the particular requirements of your plant *exactly*.

CAPACITY: Vertical-Unit Boilers are available for capacities ranging all the way from 10,000 lb of steam per hr up to 300,000 or more lb per hr.

PRESSURES—TEMPERATURES: VU Units are available for steam pressures up to 1000 psi and temperatures up to 900 F, or more.

FUEL REQUIREMENTS: The larger designs may be fired by pulverized coal, oil or gas, or any combination of these fuels. In the medium and lower capacity ranges firing may be by any type of mechanical stoker or oil or gas. Moreover, it is possible to substitute any one of these methods for another should a change in the fuel market occur.

This flexibility . . . this ability to meet the widely varying requirements of plants in virtually every branch of industry — at efficiencies ranging up to 88% — accounts for the wide acceptance of the Vertical-Unit Boiler. Throughout the United States and Canada, Latin America and abroad, the VU has been selected for installations with an aggregate capacity of well over 100,000,000 lb of steam per hour.

Whether you are considering the purchase of equipment for replacement or expansion, or for a new plant, a C-E Vertical-Unit Boiler will provide the right answer to your particular situation. We shall be pleased to supply catalogs and any additional information upon request. 392-A

— SUPERHEATER, INC.

200 MADISON AVENUE NEW YORK 16 N Y

C-E

Throw it back!

This is a fish? Fish don't walk! Throw it back!

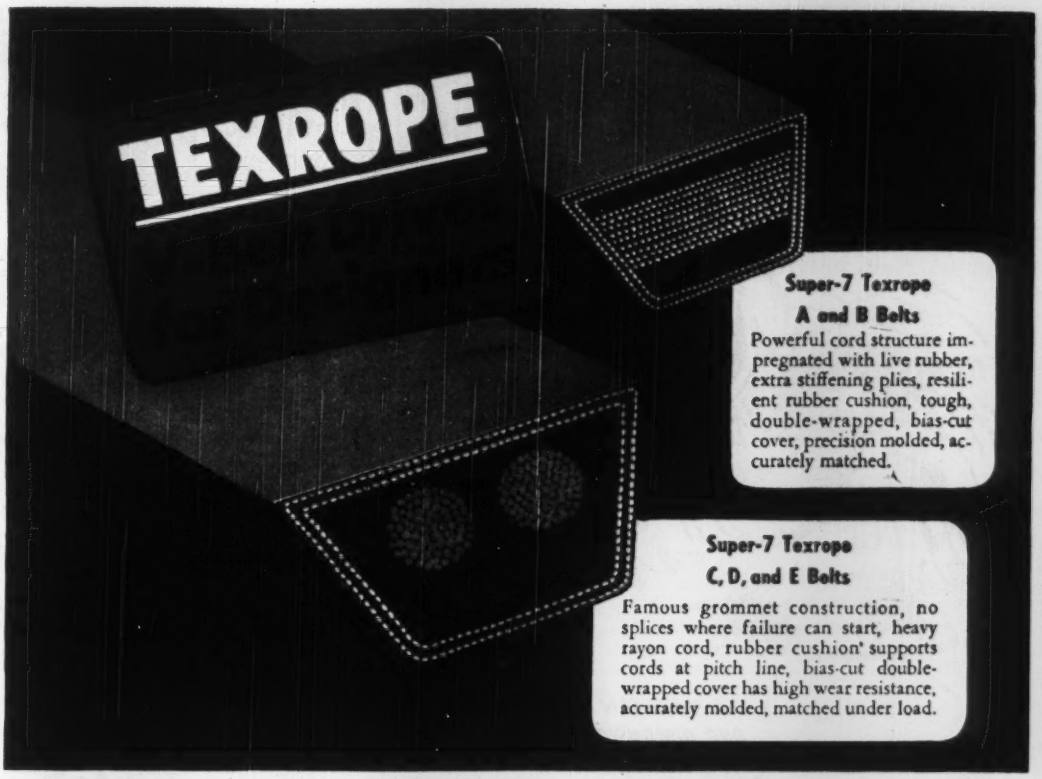
Whatever it is, it illustrates our story. There are no freaks in a Carrier system. And no "weak links" either. For air conditioning, refrigeration or heating that you can depend on—depend on Carrier all the way.

Your customers will get a better job if you see that it's completely Carrier. And if you supply genuine Carrier equipment all the way through, it will go right on being a better job.

It makes sense, doesn't it? Follow it and nobody will ever say about one of your installations, "Throw it back!"

To satisfy customers, just remember that every significant advance in air conditioning in the last half century has come from Carrier. These are a few of the Carrier products available: Conduit and Duct-type Weathermaster systems for the multi-room building; Evaporative Condensers; Central Air Conditioners; Dehumidifiers; Self-contained Air Conditioners; Reciprocating, Centrifugal and Absorption Refrigeration Machines; Cold Diffusers and Heat Diffusers. Carrier Corporation, Syracuse, N. Y.

Carrier AIR CONDITIONING • REFRIGERATION • INDUSTRIAL HEATING



Super-7 Texrope
A and B Belts

Powerful cord structure impregnated with live rubber, extra stiffening plies, resilient rubber cushion, tough, double-wrapped, bias-cut cover, precision molded, accurately matched.

Super-7 Texrope
C, D, and E Belts

Famous grommet construction, no splices where failure can start, heavy rayon cord, rubber cushion supports cords at pitch line, bias-cut double-wrapped cover has high wear resistance, accurately molded, matched under load.

LONG V-BELT LIFE means Satisfied Customers!

YOU GET MORE than good belts when you standardize on *Super-7 Texrope* V-belts for your products. You also get the benefit of the greatest V-belt experience in the world. This means you are sure of exactly the right drive for longest life on your particular product. Allis-Chalmers originated the multiple V-belt drive, and there are more Texrope multiple V-belt drives in operation than any other make.

HIGH CAPACITY BELTS

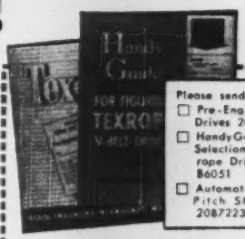
These belts have extra strong cords, special rubber cushion and tough neoprene cover to give them 40% greater capacity than standard belts at proportionately higher price. Recommended where space is limited or where a heavier duty belt is desirable.

COMPLETE V-BELT SERVICE

One reliable source for new and replacement V-belts, standard and variable speed sheaves and speed changers in all sizes.

Check coupon at right for engineering information.

Super-7 Texrope V-belts result from the cooperative research of Allis-Chalmers and B. F. Goodrich; and are sold only by A-C Dealers and offices.



Please send me:
- ☐ Pre-Engineered Drives 2086956
- ☐ Handy Guide for Selection of Texrope Drives B6051
- ☐ Automatic Vari-Pitch Sheaves 2087223

ALLIS-CHALMERS, 949A SO. 70 ST.
MILWAUKEE, WIS.

Name .....

Title .....

Company .....

Street .....

City ..... State .....

A-3103

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ALLIS-CHALMERS A-C

ORIGINATORS OF THE MULTIPLE V-BELT DRIVE FOR INDUSTRY

Why Bundyweld is

Got a special must for the tubing you use?

Must it have greater strength? sturdier walls? less weight? be easier handling? take more bending?

The tougher your specifications, the greater the chance you'll fill the bill with Bundyweld Tubing. It's double-walled from a single strip; ideal for applications from A to Z.

Just look over those Bundyweld pluses below!

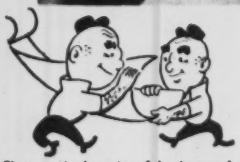
IT DUSTS OFF THE STRAIN OF BOTH SHIMMIES AND QUIVERS IN BRAKE LINES OF TRACTORS AND BUSES AND FLIVVERS.

Must your tubing part stand up under stress, strain, jolts and vibration? Most of today's cars feature brake lines of Bundyweld, finest evidence possible of the high resistance to vibration fatigue *you* can expect in extra-strong Bundyweld.

IT'S A BANTAM IN WEIGHT, WON'T LEAK UNDER STRESS, OUR DIMENSIONS ARE TRUE AND THERE'S NO SCALINESS.

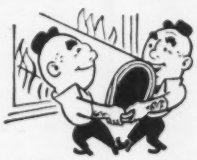
Bundyweld is rolled up *tight* and brazed through 360° of wall contact. No possible chance for leaks under pressure, inside or out, in beer coils, or gas, refrigerant, connector and compressor lines. Bundyweld's exclusive beveled edge (see lower left) eliminates inside bead, gives *uniformly* pressure-proof tube.

NOTE the exclusive patented Bundyweld beveled edge, which affords a smoother joint, absence of bead and less chance for any leakage.

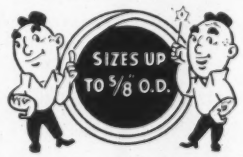


First, a single strip of basic metal, coated with a banding metal, is . . .

rolled twice around into a tube of uniform thickness, then . . .



passed through a furnace. Bonding metal fuses with basic metal, presto—

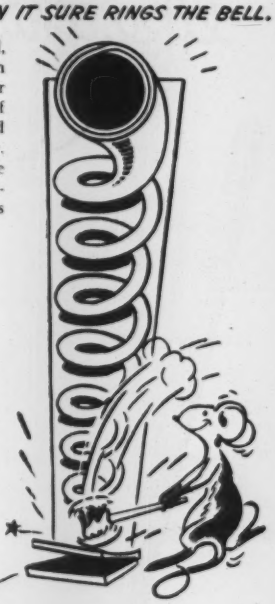


Bundyweld . . . double-walled and brazed through 360° of wall contact.

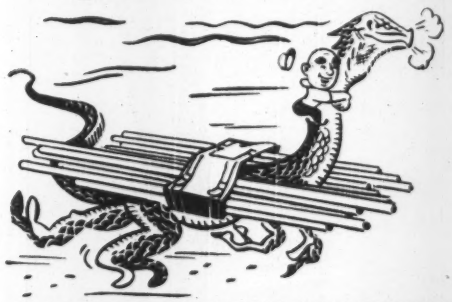
the ideal tubing

IT'S STURDY AND RUGGED, YET DUCTILE AS WELL,
FOR SMOOTH FABRICATION IT SURE RINGS THE BELL.

Bundyweld can be cut, swaged, formed, machined and joined with remarkable ease. You get speedier fabrication, lower costs. Speaking of forming, if you've a complicated bending problem, send it to Bundy. We've helped whip some of the toughest bending jobs in the business, with major savings to customers as well.



WE...LITERALLY...LATERALLY ROLL IT UP DOUBLE,
GAIN GREAT EXTRA STRENGTH THAT FREES YOU FROM TROUBLE.



An application of double-walled Bundyweld has helped many a manufacturer improve design or take production short-cuts . . . even in instances where the problem didn't seem to call for a tubing at all! Bundyweld is stronger walled, yet thinner walled; faster-heating, faster-cooling. I.D. and O.D. are held to amazingly close tolerances.

IF AN EXTRA-HOT JOB HAS YOUR PLANT IN A STEW,
PUT A CALL IN FOR BUNDY AND WATCH US CRASH THROUGH.

Customers praise Bundy service almost as much as Bundyweld Tubing itself. We'll practically do nip-ups to get to your place, talk over that stumper and turn out the order in jig time. And there's hardly a type of tubing application, be it in toys or tractors, that someone in our organization hasn't worked with before!

SO have your designers and engineers now
Get someone from Bundy to demonstrate how
Our Monel, or nickel or steel Bundyweld
Gives features and savings quite unparalleled.

FREE! The above only hints at all the features Bundyweld offers. Why not send for our 20-page illustrated booklet and get the full Bundyweld story. It may well help spark a major money-saving Bundyweld use for you. For booklet, or for any query on a use of tubing, just call or write: ***Bundy Tubing Company, Detroit 14, Michigan***

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Bundy Tubing Distributors and Representatives: Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • **Chattanooga 2, Tenn.:** Poirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • **Chicago 32, Ill.:** Lapham-Hickey Co., 3333 W. 47th Place • **Elizabeth, New Jersey:** A. B. Murray Co., Inc., Post Office Box 476 • **Philadelphia 3, Penn.:** Rutan & Co., 404 Architects Bldg. • **San Francisco 10, Calif.:** Pacific Metals Co., Ltd., 3100 19th St. • **Seattle 4, Wash.:** Eagle Metals Co., 3628 E. Marginal Way **Toronto 5, Ontario, Canada:** Alloy Metal Sales, Ltd., 881 Bay St. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

Ever doodle like this?

WHEN YOU'RE DAYDREAMING perhaps you, like most people, find yourself doodling pictures of the things you want most.

Maybe there's a house you have in mind you'd like to build.

Or you're wondering which college you'd like your child to attend a few years from now. Or maybe you'd like to own a *brand-new* automobile someday.

One sure way to take your daydreams out of the doodling stage—and make 'em come true—is to set aside part of your salary regularly in U. S. Savings Bonds.

Week after week, month after month, your savings will grow and grow and grow. Furthermore, in ten short years, you get back $4 for every $3 you set aside.

So sign up on the Payroll Savings Plan where you work, or the Bond-A-Month Plan where you have a checking account.

Start making your daydreams come true *right now!*

Automatic saving is sure saving—U.S. Savings Bonds

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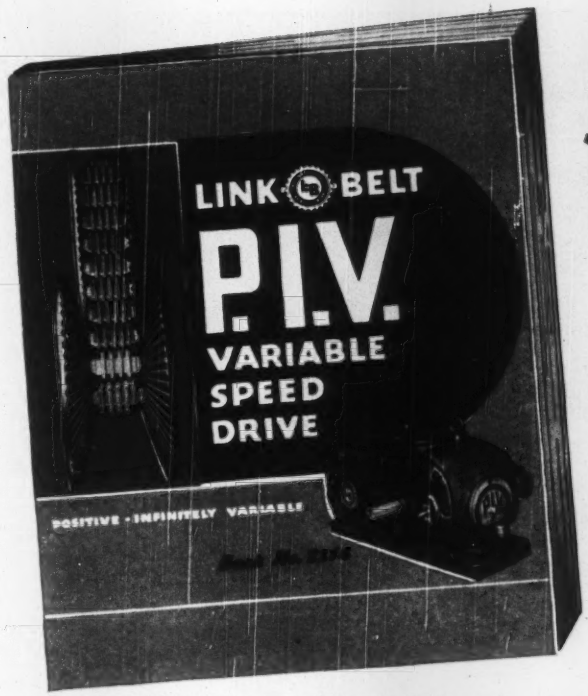
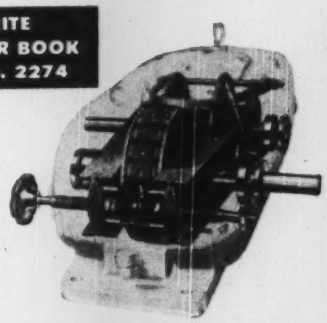


Pre-selected drives occupy over 25 pages of this entirely new book, making it extremely easy to select an accurate, variable speed drive.

This NEW Book Shows How to Obtain QUICK, EASY, ACCURATE SPEED CONTROL

WRITE FOR BOOK NO. 2274



THERE'S ONLY ONE P.I.V.

Wherever speed is a factor in manufacturing operations or processes, the supremacy of the Link-Belt P.I.V. variable speed drive becomes readily apparent, as a means of providing precise control, instantly variable, and reliably constant over long periods. Power is transmitted from input to output shaft through a *unique chain* which makes *positive* engagement with radial grooves on two pairs of opposed driving wheels. Movement of the control screw simultaneously varies the effective diameters of these wheels. Thus an infinite number of *stepless* speed adjustments is possible between maximum and minimum settings. Because it is entirely independent of frictional elements, the P.I.V. variable speed drive *eliminates slip or creep*, ends costly guess work or hunting and extends the range of operations for greater efficiency and higher production.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg.
Offices, Factory Branch Stores and Distributors in Principal Cities.

SIXTEEN TYPES
EIGHT SIZES
1/2 TO 25 H. P.

Available in standard form for vertical or horizontal mounting and with extra input and output gears, also with motor integrally mounted. Ratios up to 6:1.

AUTOMATIC CONTROLS

Link-Belt "Job Engineered" Automatic Controls provide instant, accurate adjustment of output speed, by electrical, hydraulic, pneumatic or mechanical accessory devices. WRITE FOR BOOK 2349.

For dependable operation at efficient speed without slip; for positive, infinitely variable control of rotary motion; for rapid speed changing by manual, automatic or remote control, INDUSTRY USES

For dependable operation at efficient speed without slip; for positive, infinitely variable control of rotary motion; for rapid speed changing by manual, automatic or remote control, INDUSTRY USES

11.081

LINK-BELT

P.I.V. Variable Speed Drive

WE WELCOME
SMALL ORDERS
Quick Deliveries
Wallace Barnes Springs
Bristol Connecticut

Keeps its Shape..
no matter how much it eats and drinks

Put the Cuno MICRO-KLEAN filter on almost any kind of a diet . . . and it will stay healthy longer than any micronic filter you know of.

Handling a wide range of fluids at a wide range of flow rates . . . the MICRO-KLEAN won't *shrink* or *swell* or *channel*. So there's no place for the fluid to go except where it's supposed to . . . through the cartridge.

Its dirt capacity is *double* that of any comparable filter—so its life is that much *longer*.

Finally, you can install it—inside or outside your equipment—with no trouble at all, because it takes up less space.

Check the box nearby for an explanation of MICRO-KLEAN's exclusive performance.

No Fluid Is Better Than Its Filtration

EXPLANATION

Why won't MICRO-KLEAN *shrink or swell or channel?*
Because the fiber structure is resinous-impregnated and polymerized, and resists any deteriorating effects of most fluids and contaminants.

Why does MICRO-KLEAN *have double dirt capacity?*
Because exclusive "graded density in depth" permits smaller particles to penetrate to varying depths—no surface-loading.

Why does MICRO-KLEAN *take up less space?*
Because the cartridge is *all filter*—no structural elements, no cans, bags, springs, inserts.

Full-flow filtration needs much less room.

Also important: pressure drop is low . . . cartridge changing is easy . . . and CUNO MICRO-KLEAN IS GUARANTEED TO REMOVE ALL SOLIDS LARGER THAN SPECIFIED . . . PLUS A LARGE PROPORTION DOWN TO 1 MICRON!

Wide range of applications
Cuno MICRO-KLEAN filters come in varying densities (10, 25, 50 microns) . . . capacities from a few to more than 800 gpm . . . connections from ⅜ in. IPS to 6 in. flanged . . . single or multiple cartridge units.

CUNO

COMPLETE LINE
Fluid Conditioning
Removes More Sizes of Solids from More Types of Fluids
MICRONIC Micro-Klean • DISC-TYPE Auto-Klean
WIRE-WOUND Flo-Klean

Mail this Coupon . . . for FREE Catalogs

Make Sure to Investigate MICRO-KLEAN *First*

- ☐ Lubricating Oil
- ☐ Hydraulic Oil
- ☐ Water and Water Solutions
- ☐ Compressed Air
- ☐ Fuel Oil
- ☐ Acids

CUNO ENGINEERING CORPORATION
6513 South Vine St., Meriden, Conn.
Please send information on Cuno MICRO-KLEAN for services checked.

Name.....Title.....
Company.....
Address.....
City.....State.....
PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

American Blower—a time-honored name in air handling

PHOTO COURTESY ST. LOUIS GLOBE-DEMOCRAT

In St. Louis, as in other cities, American Blower Air Handling Equipment serves commerce, industry and public utilities. For air handling data in the St. Louis area, call American Blower —Garfield 1208. In other cities, consult your phone book.

Look before you buy. There's a big difference in quality, design, quietness, operating costs and efficiency between American Blower and other air handling equipment. Comparison tests prove the superiority of American Blower products.

Air is free . . . use it profitably!

WHETHER you want a single ventilating fan or complete air handling equipment, may we suggest these 5 points to guide you:

(1) Is the proposed equipment built by a reputable manufacturer with a background of years of experience?

(2) Has the manufacturer facilities for research and testing?

(3) Are units tested in accordance with the Standard Test Code? Are ratings CERTIFIED?

(4) Are the services of experienced engineers available at conveniently located branch offices?

(5) Will the manufacturer (when it's practical) furnish equipment to run comparative tests?

If you consider the merits of the air handling equipment you are about to buy in the light of these points, we're certain you'll agree that American Blower offers more value per dollar invested.

Ask your Heating, Ventilating and Air Conditioning Contractor or our nearest Branch Office for data.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

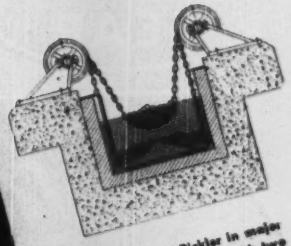
YOUR BEST BUY

AMERICAN BLOWER

AIR HANDLING EQUIPMENT

Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON



Weldco Mechanical Pickler in major Ohio steel plant, operated with two 600 AT and one 300 AT Cleveland Speed Reducers. Photo by courtesy of Youngstown Welding & Engineering Company.

Unique mechanical bar pickler driven by three CLEVELANDS

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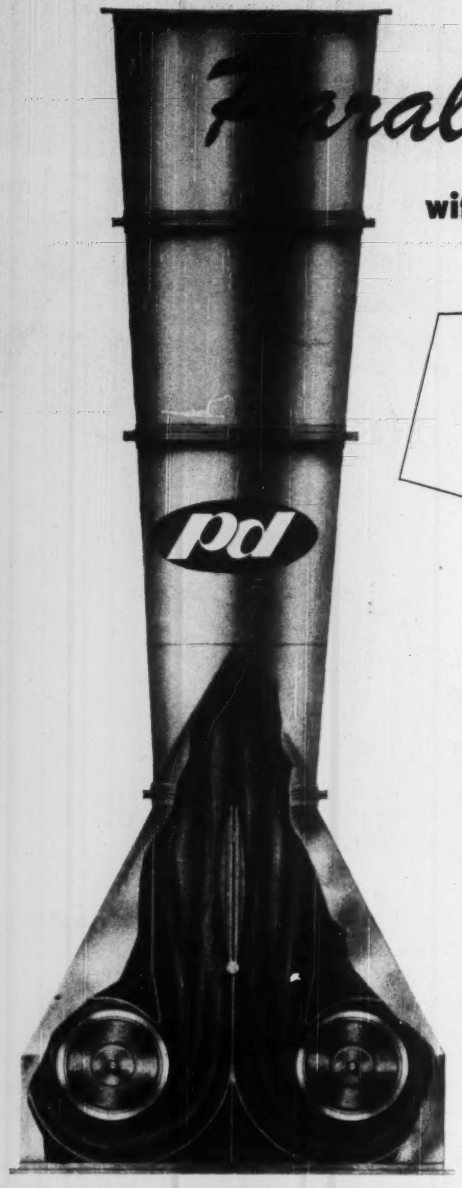

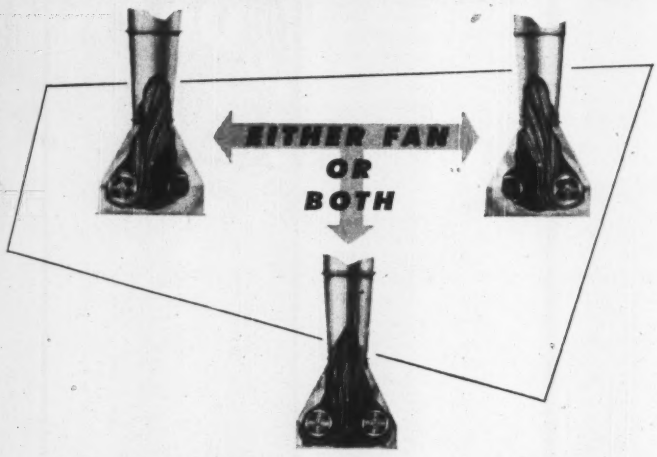

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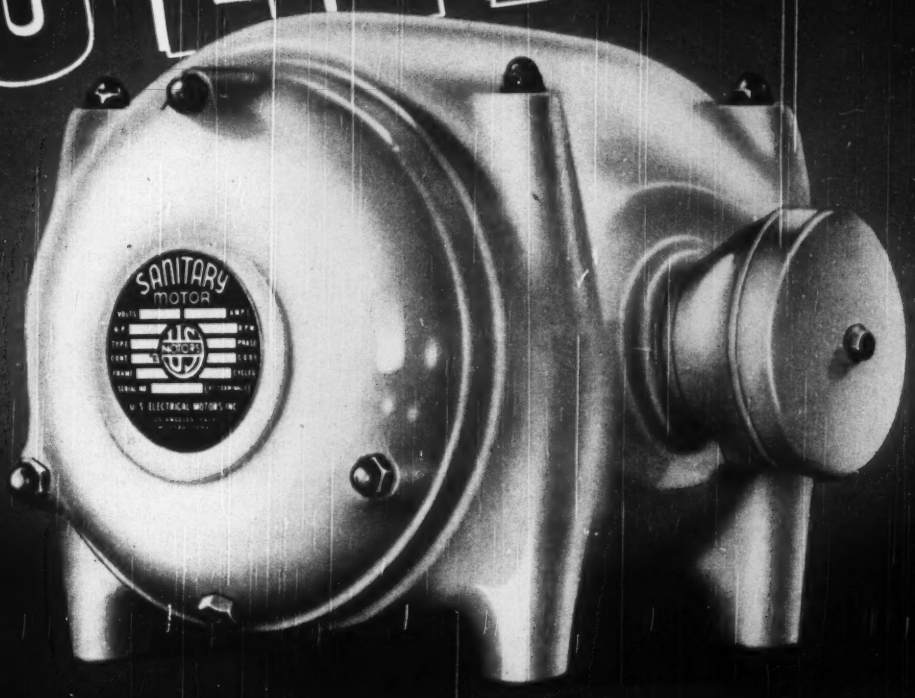

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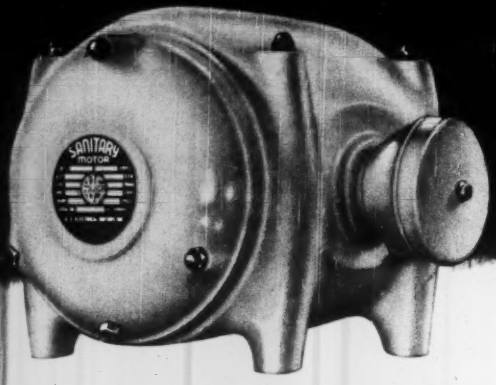

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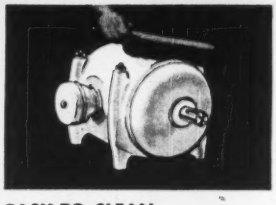

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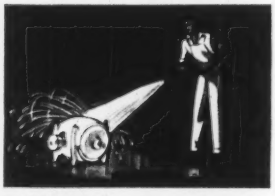

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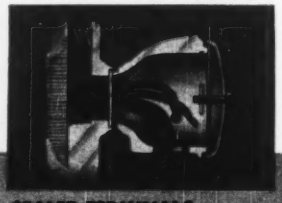

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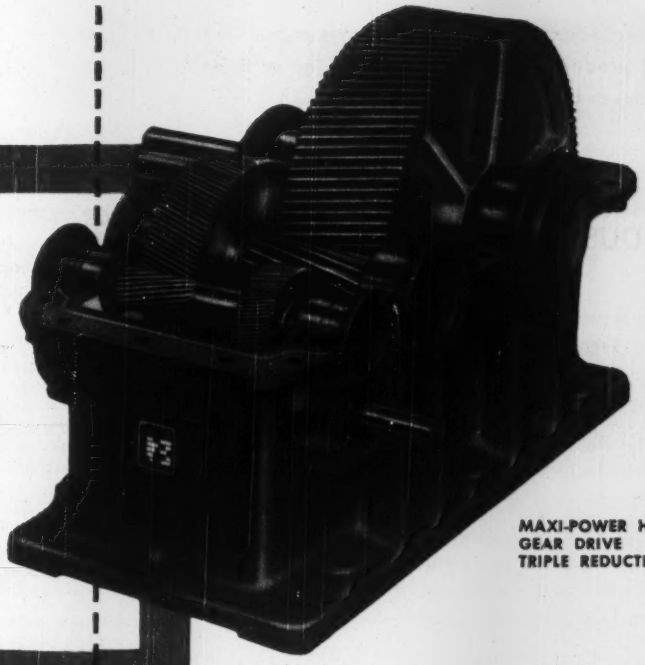

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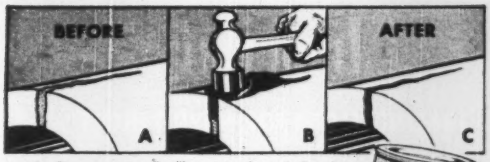

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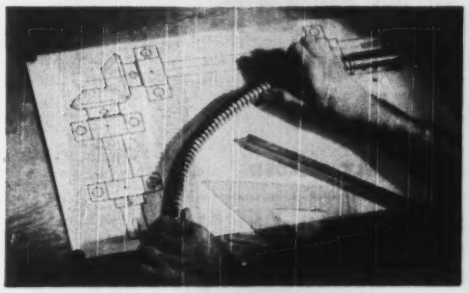

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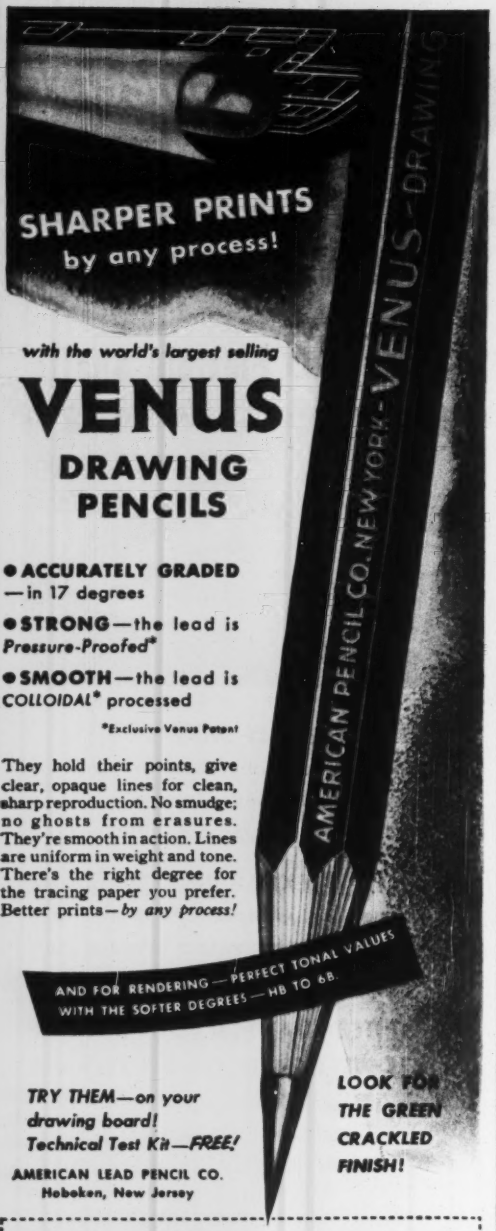

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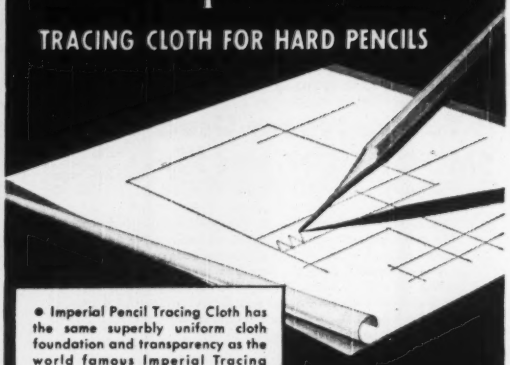

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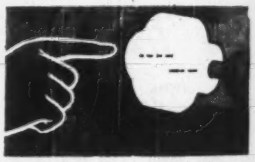

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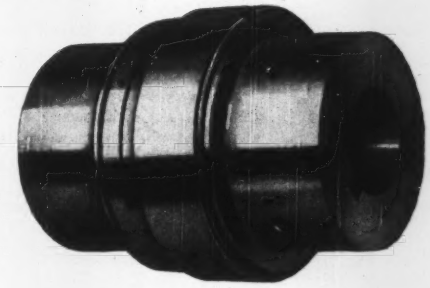

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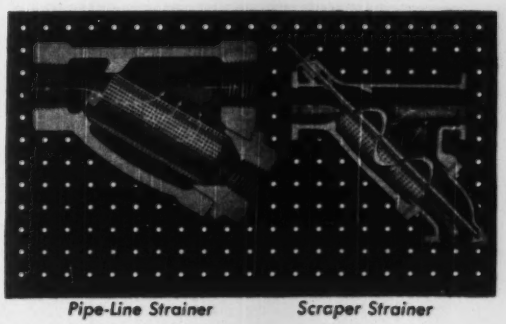

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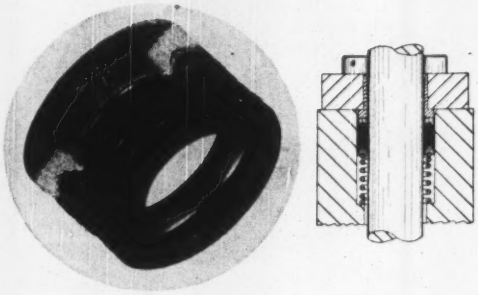
(Offer not valid outside U. S.)

20 MILLION STROKES
from
0 to 2250 PSI
Prove
LINEAR "V" RING
Efficiency



The unretouched photograph shows a cutaway section of a set of five LINEAR "V" Ring packings . . . after 20,217,960 strokes in a vertical triplex pump, handling river water with solids of seven grains per gallon.

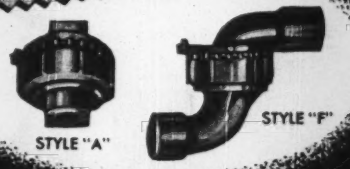
Previously the pump . . . with a rod of cold drawn Monel and operating at 144 strokes per minute . . . required an adjustable gland. But spring-loading the homogeneous type LINEAR "V" Rings permitted the use of a fixed gland, bolted metal-to-metal . . . providing automatic take-up for the packing. The result? A uniform and predictable seal life and elimination of dangerous over-tightening of the gland. When removed for examination, the LINEAR "V" Rings were sealing just as efficiently as when first installed!

In addition to these successful homogeneous "V" Rings, precision-moulded seals of fabric reinforced materials, fluoroethylene polymers, silastics and special synthetic rubbers are available to meet your specific requirements.

For lower costs and increased dependability, call LINEAR for specific information.

"PERFECTLY ENGINEERED PACKINGS"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA

For Moving Pipe Lines Safe • Dependable FLEXO JOINTS



- **INDISPENSABLE . . . for conveying fluids through movable pipe lines or equipment in motion! Complete 360° movement—with no flow restriction. Four styles for standard pipe sizes ¼" to 3".**
- **ECONOMICAL . . . simple in design, Flexo Joints contain no springs, no small or loose parts—assure long wear, extremely low maintenance cost.**
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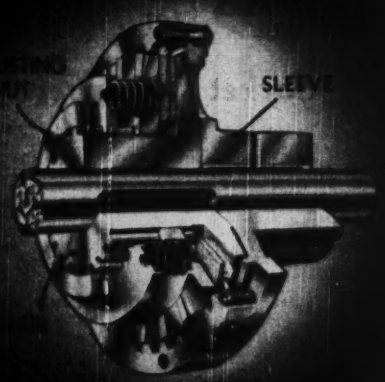
★ IMPROVE THE CONTROL OF YOUR REWIND STAND



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NOW AVAILABLE — Adjustable while running constant tension clutches. Provide ample friction surface for heavy duty use in reeling and winding operations.

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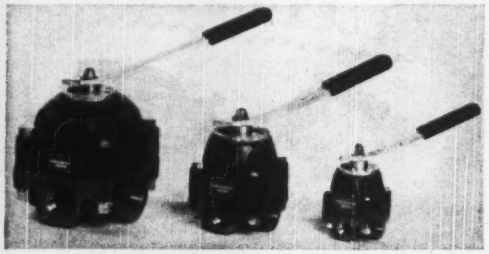

The new series of manual 4-way valves (illustrated) employs the same basic tubular seal design (low maintenance — leak proof — easy operation) which made earlier models famous. Here are some additional features of the new design: Increased flow capacity; lower handle loads; same valve may be switched from "open center" to "closed center"; same valve for panel or regular mounting; choice of Regular porting (in the run of the line), Straight porting (all four lines brought into the end) or Manifold porting (for sub panel mounting).

*You can't buy a better valve than a Barksdale—to control Water, Air or Oil—to 6000 psi. pressure.

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LEEDS & NORTHRUP CO.
4901 STENTON AVENUE
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Continued on Page 106

Two Pages of "OPPORTUNITIES" This Month . . . 105-106

POSITIONS OPEN

Continued from Page 105

MECHANICAL DESIGN ENGINEER

B.S. or Advanced Degree (or equivalent) with 5-10 years' experience in machine design on automatic machinery. Excellent future with long established company located in Connecticut. Requires high creative design ability plus practical mechanical knowledge. Write fully with knowledge that your reply will be held in strict confidence and no references checked without your permission.

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ENGINEER—Age 38. Fourteen years' diversified experience in chemical, metallurgical, and mechanical operations. Desires responsible position, engineering or production, with progressive company. Address CA-3288, care of "Mechanical Engineering."

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ASSISTANT TO PRESIDENT OR GENERAL MANAGER—of medium size manufacturing concern. Successful broad experience starting in shop on machines, Mechanical Engineering degree, product development and design, sales, plant engineering, general manager of small plant. Age 35, family. Address CA-3282, care of "Mechanical Engineering."

TROPICAL TRAMP—BSME, ASME, Age 34. 4½ years' Central America general engineering. Desirous of using experience to advantage of engineering or manufacturing firm interested in development of Latin American business. Address CA-3287, care of "Mechanical Engineering."

MECHANICAL-CIVIL ENGINEER—25 years' experience design, construction, operation metallurgical and chemical plants. 10 years in responsible charge of such work as chief engineer and project manager. Recently completed foreign contract on a general engineering project including a steam power plant, dam, harbor development, and other related work as project manager. Available October 1, for similar position anywhere U.S.A. Address CA-3289, care of "Mechanical Engineering."

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ENGINEERING EXECUTIVE—M.E., over 20 years' successful experience in design, development and production manufacture of aircraft and automotive accessories. Organizing, administrative and creative ability. Wishes position as chief engineer with progressive organization in northern New Jersey. Address CA-3293, care of "Mechanical Engineering."

MECHANICAL ENGINEER, recent graduate, Missouri School of Mines and Metallurgy. Age 26. Construction experience. Desires position in production, power, maintenance, or construction. Resumé furnished on request. Address CA-3294, care of "Mechanical Engineering."

MECHANICAL ENGINEER—B.S., 33, single, worked for 9 years for leading companies on thermodynamic power cycle analysis; design and stress analysis of rotating machinery and piping; experimental research. Seeks industrial or utility design or development work. Address CA-3295, care of "Mechanical Engineering."

MECHANICAL ENGINEER—BSME, PE, ASME, Age 32, 7 years diversified experience in process industry including design, estimating, field follow-up of construction, some combustion experience. Desires position as plant engineer or sales engineer. Address CA-3296, care of "Mechanical Engineering."

It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

MANUFACTURING ASSISTANT—Graduate M.E., age 31, 5 years' sales, 3 years' production experience, desires supervisory position in small to medium size plant. Prefer Midwest or East. Address CA-3297, care of "Mechanical Engineering."

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MECHANICAL ENGINEER—graduate—age 47—married. 13 years' mechanical superintendent in chemical industry. 10 years' experience in construction and civil engineering. Desires supervisory position or sales. Available for interview. Address CA-3299, care of "Mechanical Engineering."

SALES EXECUTIVE, M.E.—39, experienced in Engineering, Sales, and General Management. Heavy industry involving Iron and Brass Foundries and Machine Shops (Gate Valves, etc.). In charge of Sales and Advertising. Formerly Mgr. of Factory Branch in Heating and Air Conditioning field (residential). Desire position as Ass't Gen. Mgr., or comparable. Anywhere. 60 day notice. Address CA-3300, care of "Mechanical Engineering."

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This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invitrd.

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EQUIPMENT FOR SALE
EQUIPMENT WANTED
HELP WANTED
POSITIONS WANTED
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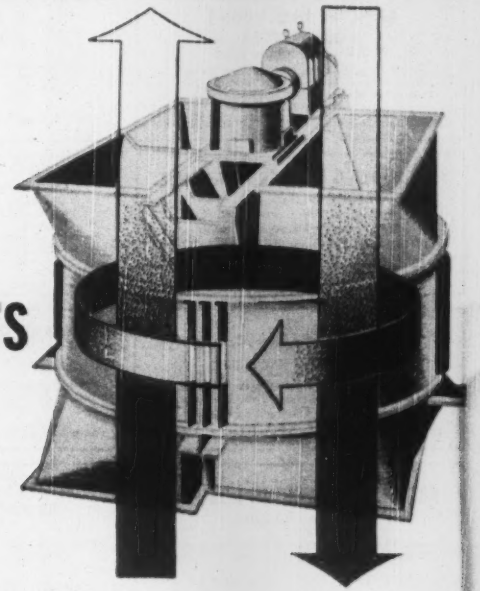
If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

How the Ljungstrom Air Preheater can modernize "middle age" boilers



The lightness and compactness of the Ljungstrom Air Preheater makes installation possible on "middle age" boilers with minimum change in the existing structure. This addition of the Ljungstrom Air Preheater, with its continuous regenerative counterflow principle permits operation at lower exit gas temperatures . . . assuring increased heat recovery and reducing the amount of fuel required.

In a matter of a few years the Ljungstrom Air Preheater will effect savings that will more than offset the initial installation cost. If you are interested in approaching modern performance standards with your "middle age" boilers, our engineers will welcome the opportunity to show you how the Ljungstrom can raise the overall efficiency of your plant.

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

THE AIR PREHEATER CORPORATION

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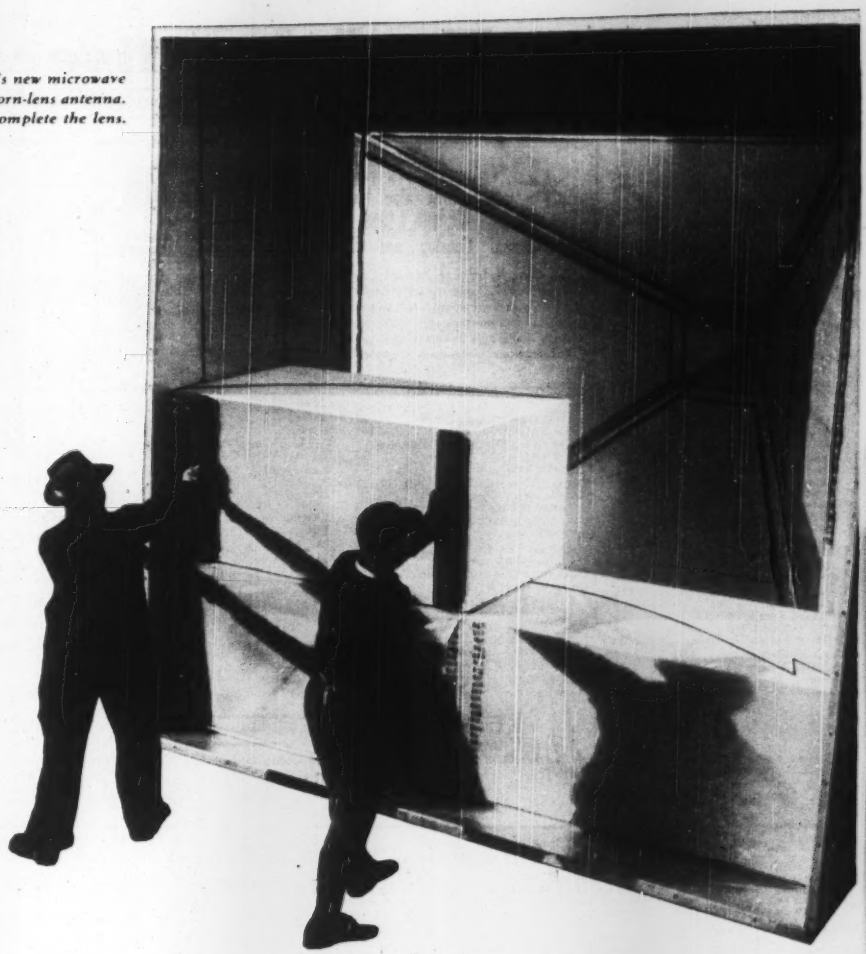
The above consultants are available
to work out solutions
to your engineering and management problems.

Mounting Bell's new microwave lens in a horn-lens antenna. Other blocks will complete the lens.



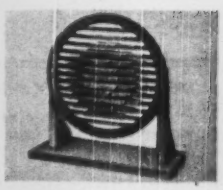
A focus on better, low-cost telephone service

In the new microwave radio relay system between New York and Chicago, giant lenses shape and aim the wave energy as a searchlight aims a light beam.

Reasoning from the action of molecules in a glass lens which focuses light waves, Bell Laboratories scientists focus a broad band of microwaves by means of an array of metal strips. To support the strips these scientists embedded them in foam plastic which is virtually transparent to microwaves. Rigid and light in weight, the plastic is easily mounted on relay towers.

This unique lens receives waves from a wave guide at the back of the horn. As they pass across the strips, the waves are bent inward, or focused to form a beam like a spotlight. A similar antenna at the next relay station receives the waves and directs them into a wave guide for transmission to amplifiers.

This new lens will help to carry still more television and telephone service over longer distances by microwaves. It's another example of the Bell Telephone Laboratories research which makes your telephone service grow bigger in value while the cost stays low.



Laboratory model of the new lens. A similar arrangement of metal strips is concealed in the foam plastic blocks in the large picture.

BELL TELEPHONE LABORATORIES

Working continually to keep your telephone service big in value and low in cost.

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MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

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City _____ State _____

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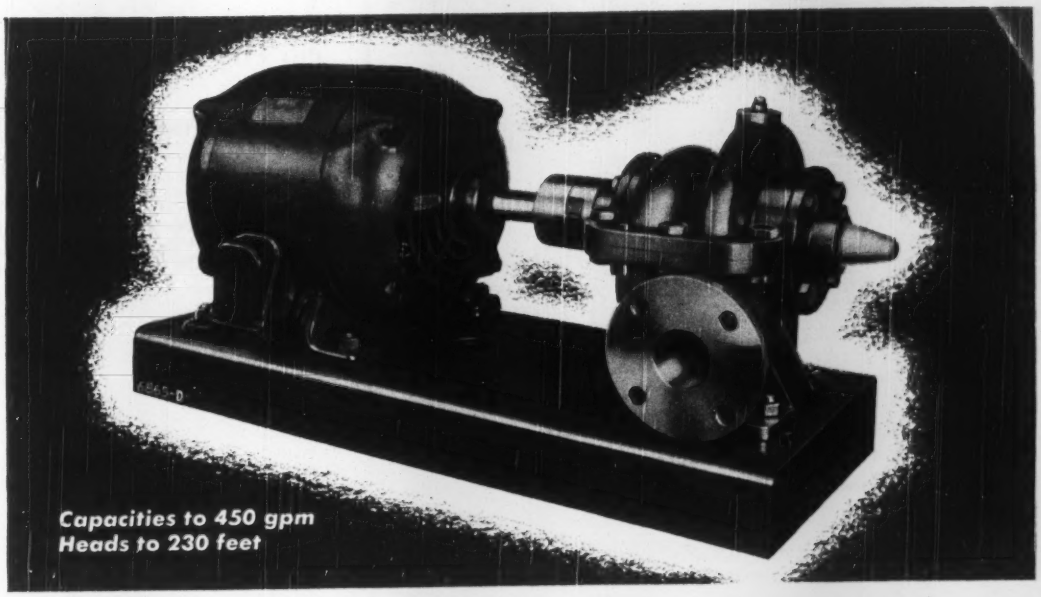
Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information—mail the coupon to us—your request will be passed on to the advertiser promptly—you will hear directly from advertiser—saves your time in writing individual letters.

We've Simplified

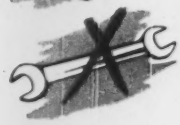
THE ALREADY SIMPLE CENTRIFUGAL PUMP

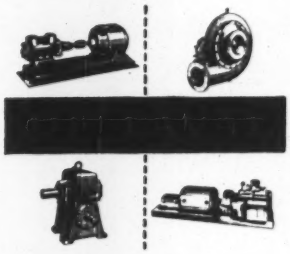


We've eliminated the stuffing boxes
The mechanical seal used in the new GS Pump never requires adjustment and never leaks. It is simple, effective and proved.

We've eliminated lubrication
Like modern, electric motors, the new GS Pump has *permanently* lubricated ball bearings.

We've eliminated field repairs
For the first time, you can let the factory do your service work. If repairs ever are necessary you can obtain a complete new rotor assembly or factory rebuilt and guaranteed pump through our Service and Exchange Plan. Or, if you wish to do your own service work, you will appreciate the fact that this pump is built with a horizontally split casing and interchangeable parts are carried in stock.

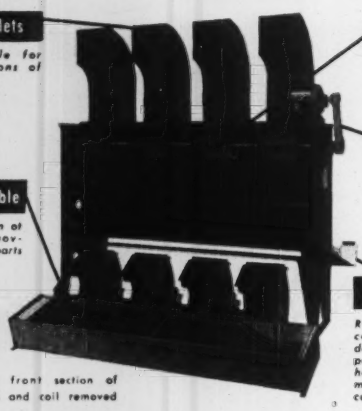




DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

10-90-PE

Here's More for Your Money ... IN CLARAGE UNIT HEATERS



Square Outlets
Easily adjustable for different directions of heat discharge.

Centrifugal Fans
One for each heater outlet. Pressure type, delivering heat over wide areas.

V-Belt Drive
For quieter operation, greater flexibility of fan capacity. (Direct connected units can be furnished.)

Readily Accessible
Front or back section of casing quickly removable. All working parts easy to get at!

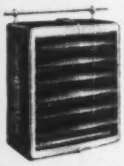
Syncrotherm Control
Regulates temperatures by controlling (with by-pass dampers) amounts of air passing through and around heating coil. Can be automatically or manually controlled.

Illustration shows front section of casing, fan housings and coil removed

SYNCROTHERM CONTROL, found *only* on Clarage Unitherms, gives you a PLUS value in factory heating! This device s-t-r-e-t-c-h-e-s your fuel dollar by utilizing *lower temperature air.*

Unitherm heat is more closely regulated, more evenly distributed floor-to-ceiling. To answer your particular requirements for either steam or hot water units, suspended type as well as floor model Unitherms are available . . . and in a wide range of sizes.

Yes, for *better* factory heating at *lower* cost, Clarage Unit Heaters — and Syncrotherm Control — merit your investigation. Check with Clarage application engineering office nearest you, or write us at Kalamazoo.



Clarco Heaters

. . . for smaller jobs, or to add capacity to present heating equipment. Wide size range of both horizontal and vertical units, steam or hot water types.

We Also Make: Complete Line of Industrial Blowers and Exhausters . . . Air Conditioning Equipment . . . Mechanical Draft Apparatus

CLARAGE FAN COMPANY – *Kalamazoo, Michigan*

CLARAGE

—HEADQUARTERS for Air Handling and Conditioning Equipment

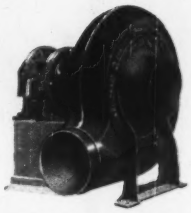
SEE OUR CATALOG IN SWEET'S

It pays to direct fan inquiries our way . . . phone Clarage office in your city, or write us at Kalamazoo.

Application Engineering Offices in All Principal Cities

Capacities to 4000 CFM

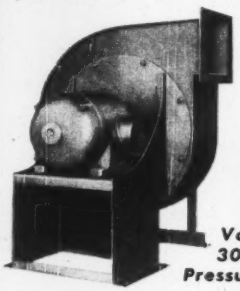
Pressures to 20"



THREE Economy Answers to Industrial Air Handling Problems

1

TYPE CI EXHAUSTERS are built to the *same exacting standards* as the largest Clarage equipment; *heavy-duty* in every sense of the word! Widely used for removing excess heat, smoke, odors from manufacturing operations . . . in pneumatic conveying . . . supplying air to oil burners, as over-fire fans, etc. Regularly furnished with corrosion-resisting cast iron housings, or in any special construction your special needs demand.



2

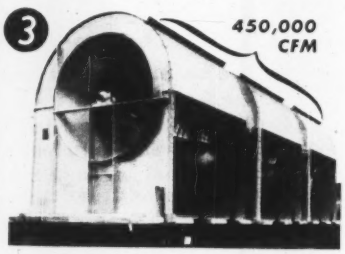
Type O Blowers

Volumes to 30,000 CFM
Pressures to 35"

For *higher pressure*, larger capacity applications . . . supplying air to cupolas, industrial gas and oil burners, etc. Fan housings and wheels of heavy steel plate "take in stride" toughest operating conditions. Clarage Type O blowers are built in 19 sizes; operate at speeds *most economical* for direct motor or turbine drive.

3

450,000 CFM



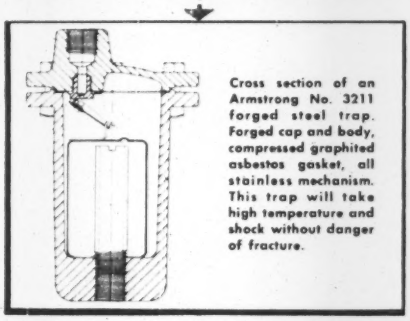
CLARAGE BUILDS equipment *big enough for ANY air handling requirement.* Example: these three Type W Fans recently shipped to a steel plant, and now installed in a large building where gas engines generate electricity. They dilute escaping toxic gas fumes, thus providing safe air for workers. Each fan delivers 150,000 cubic feet of air per minute; must operate continuously. Their *heavy-duty* qualities insure uninterrupted service on this essential job.

CLARAGE FAN COMPANY, Kalamazoo, Mich.

"Here's a Forged Steel Trap . . . for only $14.00 list"

SMALL PRICE
BIG BENEFITS

SAFETY . . . DEPENDABILITY



Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE . . LIGHT WEIGHT

NOW, for many applications, power plants, refineries, chemical processing and other industrial plants can have the advantages of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture, is ideal where all steel installations are desired. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psig; design pressure, 450 psig. Capacity range 750 to 1000 lbs/hr continuous. $\frac{1}{2}$" or $\frac{3}{4}$" pipe connections. Diameter $4\frac{1}{4}$"; height 7"; weight 8 lbs.

For higher pressures and larger capacities Armstrong builds a complete line of heavy duty forged steel traps. Ask your nearby Armstrong representative to quote on the traps you need now.

ARMSTRONG MACHINE WORKS
894 Maple St., Three Rivers, Mich.

SEND FOR your copy of the Armstrong Steam Trap Book giving complete data and prices on all Armstrong steam traps, both forged and cast bodies for all pressures, all applications. This 56-page book is a valuable reference for any engineer working with selection and installation of steam traps.

ARMSTRONG STEAM TRAPS

NEW STANDARDS of ACCURACY with NEW TIMKEN® "00" BEARINGS

For lathe spindles, gear cutters, dividing heads, small rolling mills and other precision applications

MAXIMUM run-out tolerance only 75 *millionths* of an inch! That's the amazing precision achieved in the new Timken® "Double-Zero" bearing! It is twice as accurate as the Timken "Zero"—previously the most accurate Timken bearing made.

This sensationally low run-out tolerance opens up new opportunities for increased precision in a wide range of products. Already many manufacturers are using the new "00" bearing to increase precision in lathe spindles, gear cutters, dividing heads, small rolling mills, grinding machine spindles and other precision equipment. And production of the new Timken "00" bearings has been increased to meet the demand.

To make these new bearings possible, Timken Roller Bearing Company engineers have built specialized machine tools, developed measuring devices of extreme accuracy and perfected new manufacturing processes.

If you make a product that can benefit from greater bearing precision, you'll want to learn more about the new Timken "Double-Zero" bearing. It is produced in the types and sizes indicated below. For further information write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

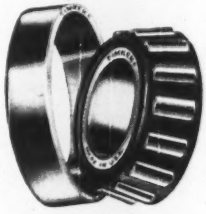
A PRECISION TIMKEN BEARING FOR EVERY REQUIREMENT

CLASS	"00" (DOUBLE-ZERO)	"0" (ZERO)	"3" (THREE)
RUN-OUT	.000075″	.000150″	.000300″
TYPES AVAILABLE	Standard Single Row	Standard Single Row	All types
SIZE RANGE	Up to 10″ O.D.	Up to 12″ O.D.	Up to 12″ O.D.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION